Miscellaneous Paper GL-96-19
August 1996

US Army Corps
of Engineers
Waterways Experiment
Station

Airfield Pavement Evaluation, Butts Army Airfield, Fort Carson, Colorado

by Jeb S. Tingle

Distribution is authorized to U.S. Government agencies only; test and evaluation; August 1996. Other requests for this document shall be referred to Headquarters, U.S. Army Corps of Engineers (CEMP-ET), Washington, DC 20314-1000.

Prepared for U.S. Army Center for Public Works

Miscellaneous Paper GL-96-19
August 1996

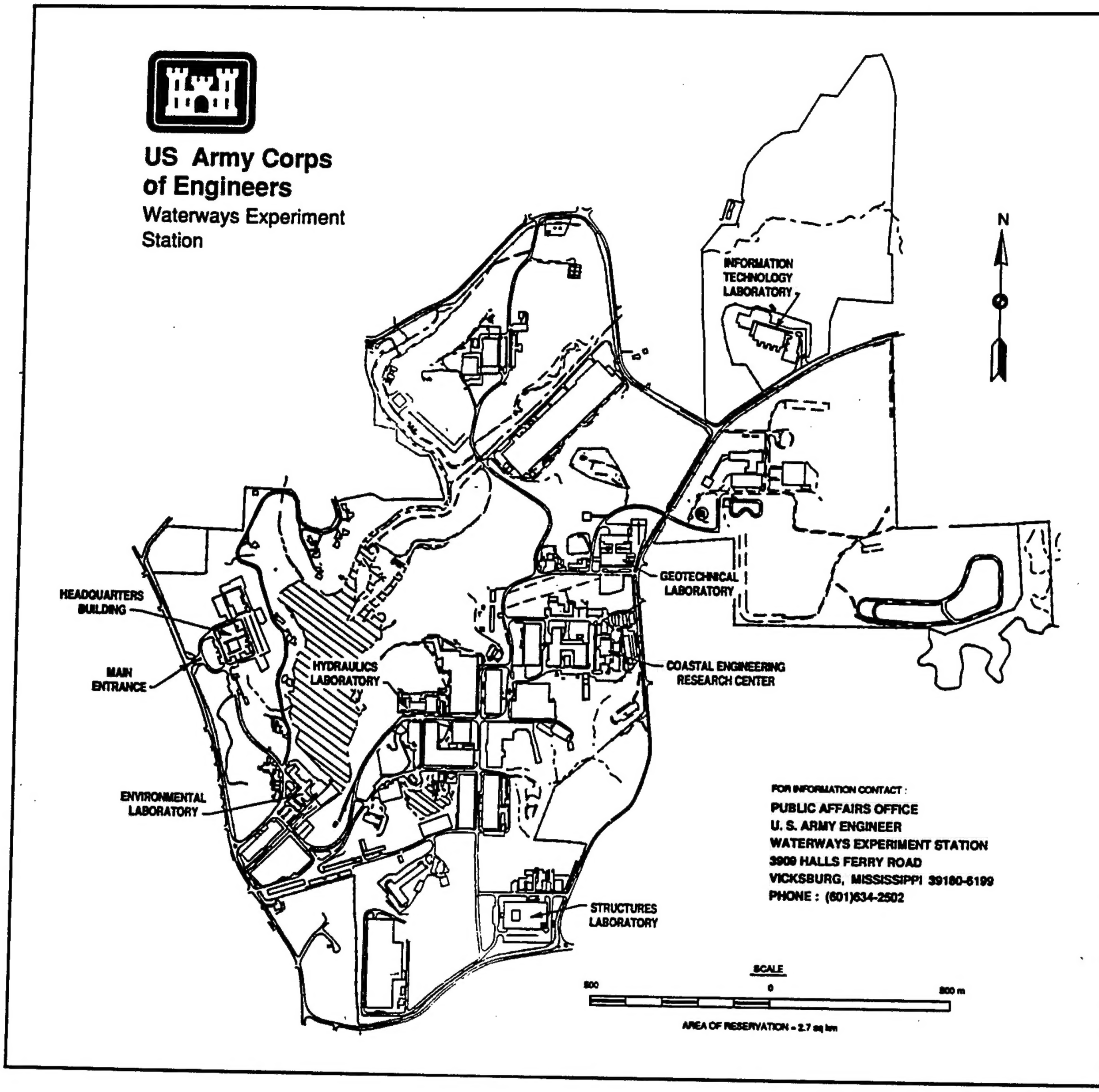
Airfield Pavement Evaluation, Butts Army Airfield, Fort Carson, Colorado

by Jeb S. Tingle

U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Final report

Prepared for U.S. Army Center for Public Works
Alexandria, VA 22310-3862



Waterways Experiment Station Cataloging-in-Publication Data

Tingle, Jeb S.
Airfield pavement evaluation, Butts Army Airfield, Fort Carson, Colorado / by Jeb S. Tingle ; prepared for U.S. Army Center for Public Works.
152 p. : ill. ; 28 cm. -- (Miscellaneous paper ; GL-96-19)
Includes bibliographic references.
"Distribution authorized to U.S. Government agencies only ..."--T.p.
1. Runways (Aeronautics) -- Colorado -- Fort Carson -- Evaluation. 2. Pavements -- Colorado -- Fort Carson. 3. Air bases -- Colorado -- Fort Carson. 4. Fort Carson (Colo.) I. United States. Army. Corps of Engineers. II. U.S. Army Engineer Waterways Experiment Station. III. Geotechnical Laboratory (U.S. Army Engineer Waterways Experiment Station) IV. US Army Center for Public Works. V. Title. VI. Series: Miscellaneous paper (U.S. Army Engineer Waterways Experiment Station) ; GL-96-19.
TA7 W34m no.GL-96-19

Contents

Preface

This report provides an assessment of load-carrying capacity and condition of airfield pavements at Butts Army Airfield, Ft. Carson, Colorado. This report provides data for the following functional activities:

a. Planning and programming pavement maintenance, repairs, and structural improvements.

b. Designing maintenance, repair, and construction projects.

c. Determining airfield operational capabilities.

d. Assembling information for aviation flight publications and mission planning.

Users of information from this report include installation Directorate of Public Works (DPW), engineering design agencies (DPW's, U.S. Army Corps of Engineers), installation Airfield Commanders, U.S. Army Aeronautical Services Agency (USAASA), and agencies assigned operations planning responsibilities. Information concerning aircraft inventory, passes, and operations shall not be released outside U.S. Government agencies. This report satisfies the requirements for condition inspection and structural evaluation established in Army Regulation AR 420-72 (Headquarters, Department of the Army 1991a) and supports the airfield survey requirements identified in Army Regulation AR 95-2 (Headquarters, Department of the Army 1988).

The Army Airfield Pavement Evaluation (AAFEVAL) Program is managed by the U.S. Army Center for Public Works and technically monitored by the U.S. Army Corps of Engineers Transportation Systems Center (CEMRO-ED-TX) located in Omaha, NE. Funding for this airfield evaluation was provided by U.S. Army Center for Public Works (CECPW-ER).

This publication was prepared by the U.S. Army Engineer Waterways Experiment Station (WES) based upon pavement structural testing and condition survey work at Butts Army Airfield, Ft. Carson, Colorado, on 6 through 9 December 1995. The survey team consisted of Messrs. James A. Harrison, Jeb S. Tingle, Louis W. Mason, and LT COL Randall W. Brown, Airfields and Pavement Division (APD), Geotechnical Laboratory (GL). This publication was

prepared by Mr. Jeb S. Tingle under the supervision of Dr. Albert J.Bush, III, Chief, Technology Applications Branch, APD, and Mr. Timothy W. Vollor, Acting Chief, APD. The project was under the general supervision of Dr. William F. Marcuson, III, Director, GL, WES.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

Recommended changes for improving this publication in content and/or format should be submitted on DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forwarded to U.S. Army Center for Public Works, ATTN: CECPW-ER, 7701 Telegraph Road, Alexandria, VA 22310-3862.

Executive Summary

The field testing at Butts Army Airfield, Fort Carson, CO, was conducted in December 1995 by the U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS. The structural capacity and physical properties of the pavements were determined from nondestructive tests using a heavy weight deflectometer (HWD), measurements taken in previous studies at selected locations on the airfield, and dynamic cone penetrometer (DCP) tests. An inspection of the surface of each airfield pavement feature was also conducted to establish the condition of the airfield surface as opposed to its load-carrying capacity.

The results of the tests and visual inspection reveal the following:

a. The airfield pavement facilities and their assigned Pavement Classification Number (PCN) are: Runway 13-31, 40/F/C/W/T; Alpha Lane (old Runway 4-22), 4/F/C/W/T; North Taxiway, 24/F/C/W/T; Midfield Taxiway, 26/R/C/W/T; Connecting Taxiway, 5/F/C/W/T; Compass Swing Base Taxiway, 11/F/C/W/T; North Warm-up Apron, 11/F/C/W/T; South Warm-up Apron, 15/F/C/W/T; Hover Lane, 12/F/C/W/T; Parking Apron A4B, 18/R/C/W/T; Parking Apron A5B, 19/R/C/W/T; Parking Apron A6B, 19/R/C/W/T; Parking Apron A7B, 18/R/C/W/T; Parking Apron, A8B, 18/R/C/W/T; Parking Apron A9B, 29/R/C/W/T; East Rotary-wing Apron, 11/R/D/W/T; West Rotary-wing Apron, 11/R/D/W/T; Compass Swing Base, 10/R/C/W/T; and Avum Hangar Apron, 12/R/C/W/T. An airfield pavement evaluation chart showing the facilities and the PCN for each facility is shown in Figure 2-1.

b. Runway 13-31(except feature R1A) and Feature A9B on the Parking Apron of the airfield are structurally adequate to support mission requirements (i.e. peacetime) for the next 20 years. The Compass Swing Base Apron, the Avum Hangar Apron, the East Rotary-Wing Apron, the West Rotary-Wing Apron, and the Compass Swing Base Taxiway of the heliport are structurally adequate to support day-to-day mission requirements (i.e. peacetime use) for the next 20 years. The remaining features require repair and construction to support day-to-day mission requirements.

c. The surface condition of the pavements indicates that maintenance and repair (M&R) will be required for various sections of the airfield/heliport. The M&R suggested in Chapter 3 should be planned now and

accomplished within the next 2 years in order to prevent further deterioration. Due to the severity of the block cracking and weathering on the surfaces of features R1A, T1A, T2A, T5A, A1B, A2B, and A3B, Foreign Object Damage (FOD) is a problem for aircraft operating with engines running.

d. In planning structural improvements and/or reconstruction requirements, it should be recognized that TM 5-825-1/AFMAN 32-8008, Vol. 1 (Headquarters, Departments of the Army and Air Force, 1994) specifies that Portland cement concrete (PCC) or composite pavements with a rigid overlay be used in numerous airfield pavement areas, such as the ends of all runways, primary taxiways, and primary parking aprons.

e. Overloading the pavement facilities may shorten their life expectancy.

f. PCN's for the thaw-weakened periods are provided in Table D4 as guidance to the airfield operator for managing aircraft traffic during the thaw periods which generally occur during the November through April time frame.

Additional details on structural capacity, surface condition and work required to maintain and strengthen the airfield/heliport are contained in Chapters 2 and 3 of this report.

1 Introduction

Background

In May 1982 the Department of the Army initiated a program to determine and evaluate the physical properties, the load-carrying capacity for various aircraft, and the general condition of the pavements at major U.S. Army airfields (AAFs). The U.S. Army Center for Public Works (CECPW-ER) now sponsors a program for periodic evaluation of Army Airfield facilities in accordance with Army Regulation AR 420-72 (Headquarters, Department of the Army 1991a). All category 1 AAFs and instrumented U.S. Army Heliports (AHPs) are included in the CECPW-ER program. The evaluation of the airfield pavements was performed to determine the structural adequacy of the existing pavements to accommodate mission aircraft and to identify maintenance, repair, and construction work requirements.

Objective and Scope

The primary objectives of this investigation were to determine the allowable aircraft loads, and to identify maintenance, repair, and structural improvement needs for each airfield pavement feature. These objectives were accomplished by:

a. Obtaining records of day-to-day traffic operations from the installation Airfield Commander.

b. Structural evaluation of the airfield pavements in accordance with TM 5-826-1/AFJMAN 32-1036/DM 21.7 (Headquarters, Departments of the Army, the Air Force, and the Navy Draft) using the nondestructive testing device and selective sampling of pavement materials.

c. Performing a condition survey to determine pavement distresses (type, severity, and magnitude) in accordance with ASTM D 5340-93 and using analysis features of the Micro PAVER pavement management system.

The results of this study can be used to:

a. Provide preliminary engineering data for pavement design (Appendices A and B).

b. Assist in identifying and forecasting maintenance and repair work, the preparation of long range work plans, and programming funds for the various work classification categories (Appendices C and E).

c. Determine type and gross weights of aircraft that can operate on a given airfield feature without causing structural damage or shortening the life of the pavement structure (Appendix D).

d. Determine aircraft operational constraints as a function of pavement strength and surface condition (Appendix D).

e. Determine the need for structural improvements to sustain current level of aircraft operations (Appendix D).

f. Determine the need for structural improvements to accommodate increased use of the airfield (e.g., to accommodate mobilization out-loading or new aircraft mission) (Appendix D).

Chapter 2 of this report includes the results of the aircraft classification number-pavement classification number (ACN-PCN) analysis for use of U.S. Army Aeronautical Services Agency (USAASA) personnel, airfield commanders, and Deputy Chief of Staff for Operations and Plans (DCSOPS) personnel. Chapter 3 contains maintenance, repair, and structural improvement recommendations for use by Directorate of Public Works (DPW) personnel and design agencies. Chapter 4 contains conclusions and recommendation in summary form. Detailed supporting data are provided in the appendices.

2 Pavement Load-Carrying Capacity

General

The load-carrying capacity is a function of the strength of the pavement, the weight of the aircraft loads, and the number of applications of the load. The method used to report pavement load-carrying capacity is the ACN-PCN system as adopted by the International Civil Aviation Organization (ICAO). The United States as a participating member of ICAO is required to report pavement strength in this format. The ACN-PCN format also provides the airfield evaluation information required by AR 95-2 (Headquarters, Department of the Army 1988).

The ACN and PCN are defined as follows: The ACN is a number which expresses the relative structural effect of an aircraft on both flexible and rigid pavements for specific standard subgrade strengths in terms of a standard single-wheel load. The PCN is a number which expresses the relative load-carrying capacity of a pavement for a given pavement life in terms of a standard single-wheel load. An example of a PCN five part code is as follows:

25 /F /B /W /T

- PCN derived from technical evaluation
- Tire pressure code W: High tire pressure (no limit)
- Subgrade strength B: Medium (CBR 8-13)
- Pavement type F: Flexible
- PCN = 25: Indication of load-carrying capacity. Example C-130 loaded to 64 Mg (140 kip)[1]

---

[1] Most of the dimensions and measurements reported were obtained in non-SI units. All such values have been converted using the conversions given in ASTM E 380.

The system works by comparing the ACN to the PCN. If the ACN is equal to or less than that of the PCN, the pavement is expected to perform satisfactorily for the analysis period which is typically 20 years. If the ACN is slightly higher than the PCN, the pavements may be able to carry the load of the aircraft but the pavement's life will be shortened. If the ACN is significantly higher than the PCN, only a few applications of that aircraft load may lead to the structural failure of the pavement.

Load-Carrying Capacity

The first step in determining the load-carrying capacity of the pavements at Butts Army Airfield (BAAF), Fort Carson, CO, was to estimate the traffic to which the airfield will be subjected over the next 20 years. The airfield commander at BAAF requested that the airfield be evaluated for 12,000 passes of a 61,236 kg (135,000 lb) C-130 aircraft. Previous evaluations indicated that portions of the airfield would not be structurally capable of supporting the C-130 aircraft for a significant number of passes. The airfield commander has since closed these airfield features to fixed-wing aircraft, essentially reducing these features to a heliport (features T1A, T4B, T5A (old Runway 4-22), A10B, A11B, A12B, and A13B). Therefore, the airfield commander requested that these features be evaluated for 50,000 passes of a 22,680 kg (50,000 lb) CH-47 rotary-wing aircraft. Using this traffic information, results of the data analysis, and information from previous reports, the ACN values for the critical aircraft operating on the BAAF pavements were determined. These values are designated as the operational ACN. For the fixed-wing facilities, the operational ACN is 29/R/D/W/T for rigid pavements and 26/F/C/W/T for flexible pavements. For the rotary-wing facilities, the operational ACN is 10/F/C/W/T for flexible pavements and 10/R/C/W/T for rigid pavements. (See Table D5 for description of the five component ACN or PCN code). The numerical ACN values calculated for the critical aircraft operating on AC and PCC pavements on each of the four subgrade categories are presented in Table D2.

The critical PCN value for each airfield facility is presented in the Airfield Pavement Evaluation Chart (APEC) which is presented in Figure 2-1. A summary of allowable loads and overlay requirements determined for the critical aircraft and its design pass level is shown in Table D3. This table shows that the load-carrying capacities of Runway 13-31 (except feature R1A), Feature A9B on the Parking Apron, the Compass Swing Base Apron, the Compass Swing Base Taxiway, the East Rotary-Wing Apron, the West Rotary-Wing Apron, and the Avum Hangar Apron are capable of sustaining the mission traffic over the 20-year analysis period. The remaining pavement features are not capable of sustaining the mission traffic over the 20-year analysis period.

The number of passes of mobilization and contingency aircraft loadings that could be sustained by each facility is dependent on the ACN of the aircraft and the critical PCN of the facility. During wartime, many aircraft are allowed to carry heavier loads than during peacetime, which means that the aircraft would have a higher ACN because of the higher loading and would cause more damage

per pass than in peacetime. Also, under some contingency plans or during emergencies, heavier aircraft than the design aircraft (12,000 passes of a 61,236 kg (135,000 lb) C-130 aircraft and 50,000 passes of a 22,680 kg (50,000 lb) CH-47 aircraft) could be considered for using the airfield pavements. These aircraft would generally have higher ACN values and cause more damage than those normally using the airfield. The operational life of the pavement will be reduced if it is subjected to aircraft loadings having higher ACN values than the PCN of the facility. Appendix D contains an example of a procedure to determine the impact of mobilization and contingency aircraft operations.

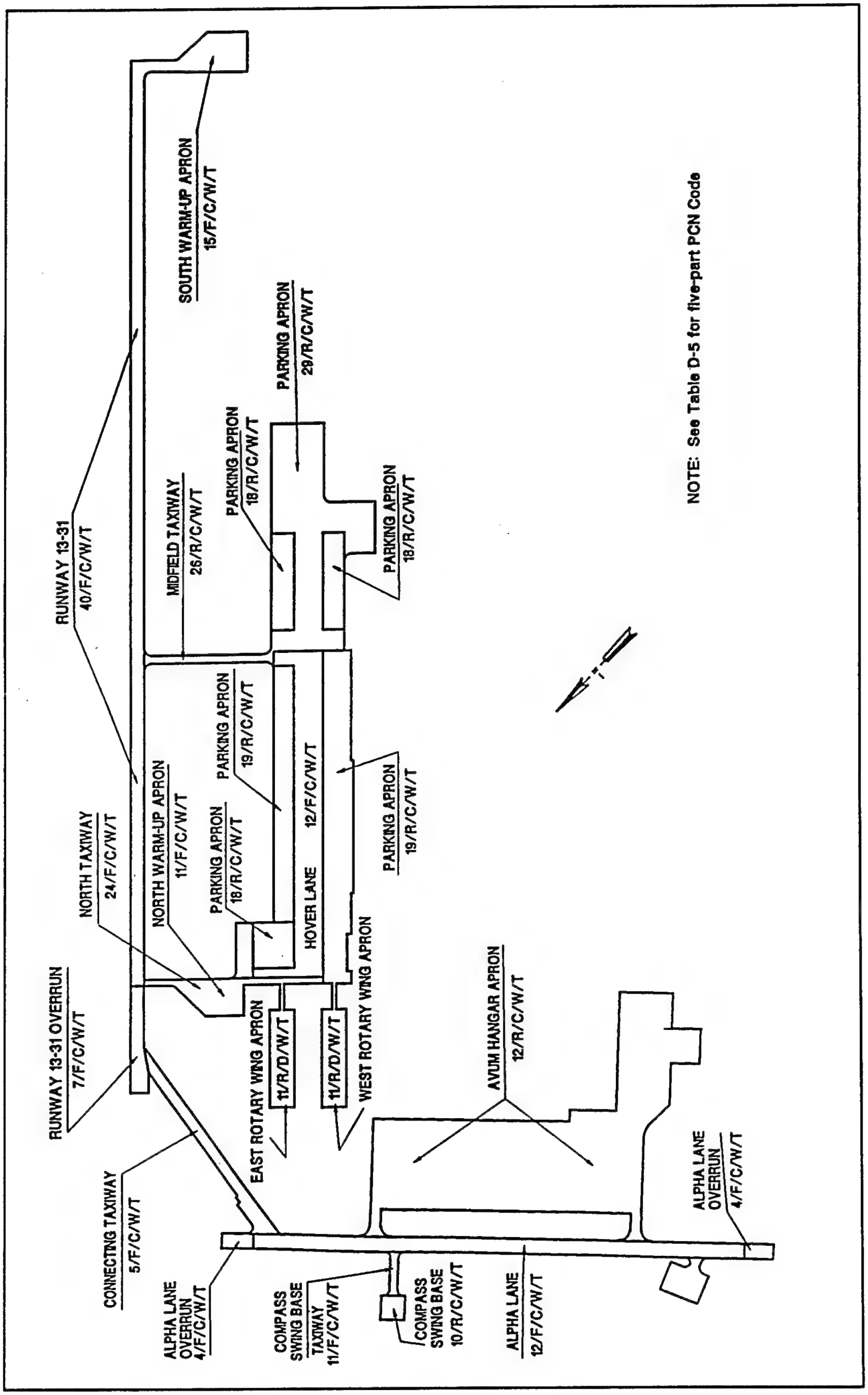


Figure 2-1. Airfield pavement evaluation chart (APEC)

3 Recommendations for Maintenance, Repair, and Structural Improvement

General

Recommendations for maintenance, repair, and structural improvements are based on results from both the structural evaluation (Appendix D) and the pavement condition survey (Appendix C). Either or both the evaluation or the survey may indicate a particular feature needs repair and/or improvement. In general, if the Pavement Condition Index (PCI) is below the required values contained in Army Regulation AR 420-72 (Headquarters Department of the Army 1991a), the pavement needs maintenance to improve its surface condition. If the ACN/PCN determined for the critical aircraft is greater than 1, the pavement needs structural improvement. Where both evaluations indicate improvements are needed, the recommendations are made such that the repairs to the surface are those needed until the structural improvements can be made. If the structural improvements are made first, the surface repairs may not be necessary. The PCI, ACN/PCN, and recommended general maintenance alternatives for each feature are shown in the Airfield Pavement Evaluation General Summary (Table 3-1). Specific recommendations are identified in Table 3-2.

Recommendations for structural improvements have been defined in terms of overlays in this report. In some instances overlays may not be the most cost effective or best engineering alternative for pavement strengthening. It should be noted that the overlay requirements shown in Table 3-2 were determined based on representative conditions at the time of testing and should be considered minimum values until verified by further investigation. These overlays should be used as a guide when programming funds for design projects. Prior to advertising an improvement project, a thorough pavement analysis and design should be completed to select the most cost-effective improvement technique. All designs should be reviewed by the U.S. Army Corps of Engineers Transportation Systems Center to ensure that they are in accordance with current design criteria.

Recommended overlay thicknesses follow the criteria for minimum thicknesses contained in TM 5-825-3/AFM 88-6, Chap. 3 (Headquarters,

Departments of the Army and the Air Force 1988). Where calculated thicknesses are greater than the minimum thicknesses, the values were rounded up to the next higher 13 mm (1/2 in).

Maintenance and repair (M&R) recommendations are based on the changes needed to provide the minimum required PCI. Army Regulation AR 420-72 establishes those requirements at 65 to 75 for all runways and primary taxiways and 40 to 55 for aprons and secondary taxiways.

Recommendations

Steps 1 through 5 of the flow chart shown in Figure 3-1 were used in determining the recommendations suggested in Table 3-2. The M&R alternatives suggested for the existing surfaces were selected from those listed for various distresses in rigid and flexible pavements shown in Tables 3-3 and 3-4, respectively. In many instances, the performance of a specific alternative depends upon the geographical location and expertise of local contractors. Therefore, it is suggested that the local DPW personnel review all recommendations. Local costs for the approved alternatives can then be used with the MicroPAVER program to obtain a reasonable cost estimate. All structural improvements or reconstruction should be in accordance with TM 5-825-1/AFMAN 32-8008, Vol. 1 (Headquarters, Departments of the Army and the Air Force 1994) which requires PCC at the ends of runways, primary taxiways, and primary parking apron systems. Features which are not currently PCC but are required to have a PCC surface are indicated in Table 3-2.

The PCI was developed to determine maintenance and repair needs. If the PCI is low, maintenance or repair is needed to increase the PCI. If the PCI is low and the PCN is greater than the ACN, localized maintenance or repair will generally be an acceptable solution. The recommended maintenance activities and repairs will improve the PCI to acceptable levels; however, this may not be the most cost-effective alternative. An overlay or other overall improvement may be more cost-effective than considerable localized maintenance or repairs. Certainly, if the current PCI is less than 25, overall improvements should be investigated. When an overlay is recommended, the maintenance recommended is that needed to keep the pavement serviceable until the overlay is applied. Although these recommendations will raise the PCI, their implementation does not ensure that the improved PCI will remain above the minimum levels for the analysis period. The PCN and the ACN were developed to determine the capability of an airfield pavement to safely support different aircraft. If an improvement is needed to increase the PCN to the ACN and only repairs to improve the PCI are applied, the pavement will probably deteriorate quite rapidly. If the PCN is lower than the ACN, the pavement needs an improvement to increase the load-carrying capacity so that the PCN will be greater than or equal to the ACN. In some cases, the PCI may be high while the PCN is lower than the ACN. In this case, the pavement needs an improvement to increase the load-carrying capacity of the pavement.

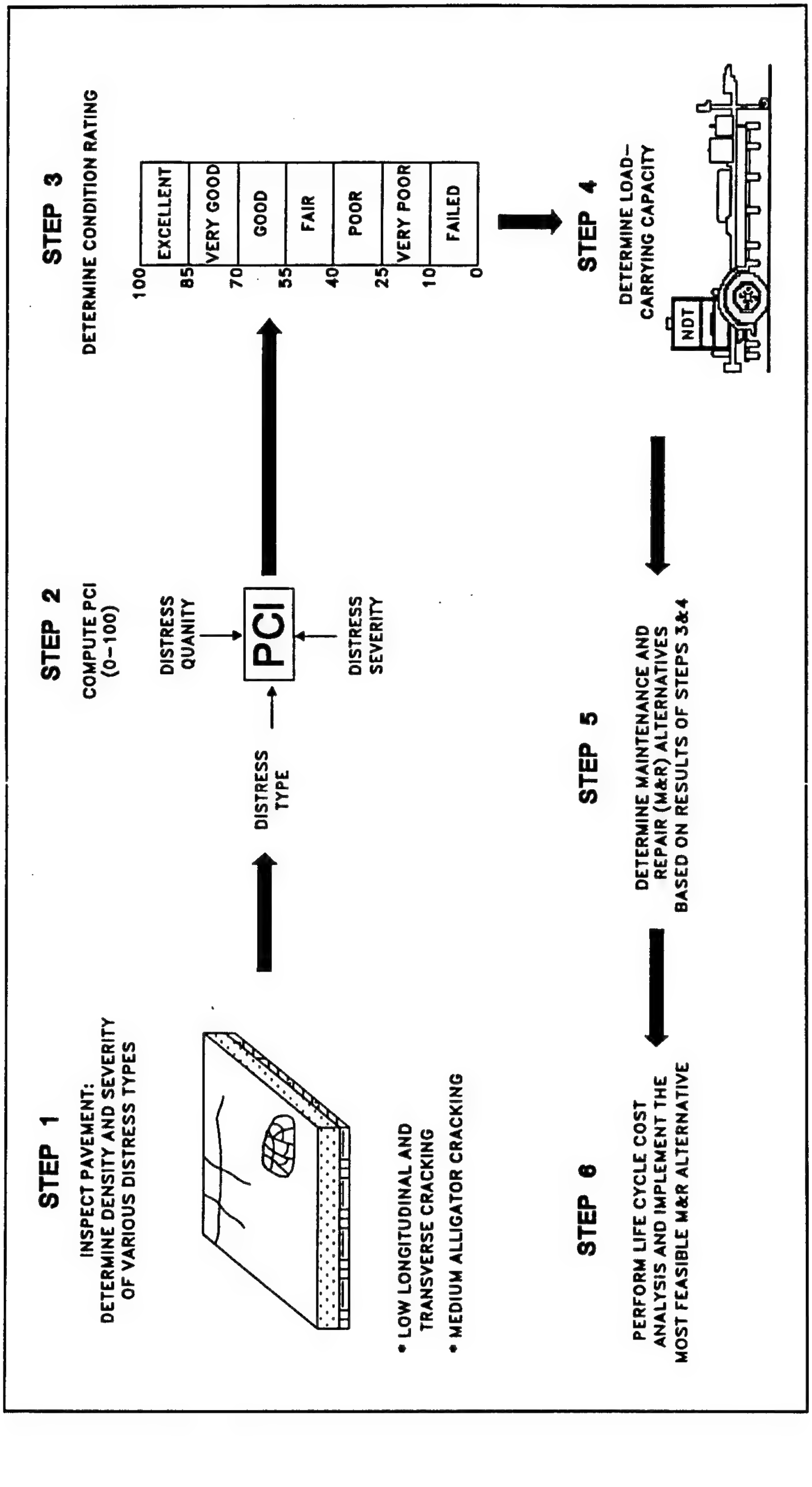


Figure 3-1. Flowchart for determination of maintenance and repair recommendations

Table 3-1
Airfield Pavement Evaluation General Summary[1]

Pavement Feature	PCI	ACN/PCN[2]	Recommendations			
			Do Nothing	Maintenance	Repair	Construction
R1A	3	3.7				X
R2A	58	0.50			X	
R3A	59	0.65			X	
R4A	55	0.59			X	
R5A	55	0.53			X	
R6A	59	0.49			X	
T1A	3	2.0				X
T2A	3	1.1				X
T3A	49	1.1			X	
T4B	22	0.9				X
T5A-1	5	2.5				X
T5A-2	5	0.83				X
T5A-3	5	2.5				X
A1B	5	2.4				X
A2B	3	1.7				X
A3B	4	2.2				X
A4B	82	1.5			X	
A5B	83	1.4			X	
A6B	76	1.4			X	
A7B	80	1.5			X	
A8B	86	1.5			X	

(Continued)

Table 3-1 (Concluded)

Pavement Feature	PCI	ACN/PCN[2]	Recommendations: Do Nothing	Maintenance	Repair	Construction
A9B	66	0.93			X	
A10B	85	1.0		X		
A11B	81	1.0		X		
A12B	79	1.0		X		
A13B	92	0.83	X			

[1] Work is categorized for preliminary planning purposes only. Classification of work for administrative approval is an installation responsibility. Policy guidance for airfield pavements is provided in AR 420-72. In general, if the pavement real property facility is in a failed or failing condition, structural improvements to accommodate normal growth and evolution of missions and equipment are properly classified as repair work. The following types of work are properly classified as construction: strengthening of a pavement to accommodate a new mission, extension or widening of the pavement, or complete replacement of the real property facility. Refer to AR 420-72 for specific guidance.

[2] Determined for design aircraft during the nonfrost period.

Table 3-2
Summary of Overlay and Maintenance Requirements for the Day-to-Day Traffic Operations for Fixed-Wing Pavements

Feature	Area sq m (sq ft)	Overlay Requirements, mm (in.)[1]			Maintenance and Repair Alternatives for Existing Surfaces
		AC	PCC (Partially Bonded)	PCC (Unbonded)	
Runway 13-31					
R1A[2]	3,483 (37,503)	203 (8.0)	--	--	Remove and reconstruct feature. Feature is now required to be PCC type construction.
R2A[2]	3,483 (37,503)	0.0	--	--	Clean medium- and low-severity cracks and seal with asphalt emulsion, cutback asphalt, or a high quality crack sealant[3]. Feature is now required to be PCC type construction.
R3A[2]	3,483 (37,503)	0.0	--	--	Clean medium- and low-severity cracks and seal with asphalt emulsion, cutback asphalt, or a high quality crack sealant[3]. Feature is now required to be PCC type construction.
R4A[2]	17,837 (191,997)	0.0	--	--	Clean medium- and low-severity cracks and seal with asphalt emulsion, cutback asphalt, or a high quality crack sealant[3]. Partial- or full-depth patching is required to correct the areas containing medium- and low-severity rutting. Feature is now required to be PCC type construction.
R5A[2]	3,483 (37,503)	0.0	--	--	Clean medium- and low-severity cracks and seal with asphalt emulsion, cutback asphalt, or a high quality crack sealant[3]. Partial- or full-depth patching is required to correct the areas containing low-severity rutting. Feature is now required to be PCC type construction.
R6A[2]	3,483 (37,503)	0.0	--	--	Same as R5A.

[1] For planning purposes only.
[2] TM 5-825-1 /AFMAN 32-8008, Vol. 1 (Headquarters, Departments of the Army and the Air Force 1994) requires that the surface be PCC.
[3] See TM 5-822-11/AFP 88-6, Chapter 7 (Headquarters, Departments of the Army and the Air Force 1993) for guidance.

(Sheet 1 of 5)

Table 3-2
(Continued)

Feature	Area sq m (sq ft)	Overlay Requirements, mm (in.)[1] AC	PCC (Partially Bonded)	PCC (Unbonded)	Maintenance and Repair Alternatives for Existing Surfaces
Connecting Taxiway					
T1A	4,644 (49,995)	64 (2.5)	--	--	Remove and reconstruct feature.
North Taxiway					
T2A[2]	2,739 (29,484)	51 (2.0)	--	--	Remove and reconstruct feature. Feature is now required to be PCC type construction.
Midfield Taxiway					
T3A	2,330 (25,083)	102(4.0)	152 (6.0)	152 (6.0)	Remove, clean, and replace old joint sealant with high quality joint sealant[3]. Clean spalls and repair with epoxy concrete. Clean medium- and low-severity cracks and seal with a high quality crack sealant[3]. Partial- or full-depth patching is required to repair medium- and high-severity spalls. Overlay as required.
Compass Swing Base Taxiway					
T4B	585 (6,300)	0.0	--	--	Clean high-, medium-, and low-severity cracks and seal with an asphalt-emulsion, cutback asphalt, or a high quality crack sealant[3].
Alpha Lane (Old Runway 4-22)					
T5A-1	1,394 (15,003)	76 (3.0)	--	--	Remove and reconstruct feature.

(Sheet 2 of 5)

Table 3-2
(Continued)

Feature	Area sq m (sq ft)	Overlay Requirements, mm (in.)[1]			Maintenance and Repair Alternatives for Existing Surfaces
		AC	PCC (Partially Bonded)	PCC (Unbonded)	
Alpha Lane (Old Runway 4-22)					
T5A-2	16,026 (172,500)	0.0	--	--	Remove and reconstruct feature due to pavement surface conditions.
T5A-3	1,394 (15,003)	76 (3.0)	--	--	Remove and reconstruct feature.
North and South Warm-Up Aprons					
A1B[2]	3,135 (33,750)	191 (7.5)	--	--	Remove and reconstruct feature. PCC type construction is now required for parking aprons.
A2B[2]	4,993 (53,748)	89 (3.5)	--	--	Same as for A1B.
Hover Lane					
A3B[2]	23,964 (257,949)	165 (6.5)	--	--	Same as for A1B.
Parking Apron					
A4B	4,034 (43,425)	102 (4.0)	152 (6.0)	178 (7.0)	Remove, clean, and replace old joint sealant with high quality joint sealant[3]. Clean all linear cracks and seal with a high quality crack sealant[3]. Clean spalls and repair with epoxy concrete. Overlay as required.

(Sheet 3 of 5)

Table 3-2
(Continued)

Feature	Area sq m (sq ft)	Overlay Requirements, mm (in.)[1]			Maintenance and Repair Alternatives for Existing Surfaces
		AC	PCC (Partially Bonded)	PCC (Unbonded)	
Parking Apron					
A5B	12,621 (135,850)	102 (4.0)	152 (6.0)	165 (6.5)	Same as for A4B.
A6B	19,161 (206,253)	102 (4.0)	152 (6.0)	165 (6.5)	Same as for A4B.
A7B	4,982 (53,625)	102 (4.0)	152 (6.0)	178 (7.0)	Remove, clean, and replace old joint sealant with high quality joint sealant[3]. Partial- or full-depth patching is required to repair high-severity scaling. Partial- or full-depth patching is required to repair spalls. Overlay as required.
A8B	4,982 (53,625)	102 (4.0)	152 (6.0)	178 (7.0)	Same as for A4B.
A9B	27,352 (294,417)	0.0	0.0	0.0	Remove, clean, and replace old joint sealant with high quality joint sealant[3]. Clean and seal medium- and low-severity linear cracks with high quality crack sealant[3]. Surface mill or grind faulting slabs. Partial- or full-depth patching is required to repair spalls.
East and West Rotary Wing Parking Apron					
A10B	4,982 (53,625)	102 (4.0)	152 (6.0)	191 (7.5)	Remove, clean, and replace old joint sealant with high quality joint sealant[3]. Surface mill or grind faulting slabs. Clean and repair spalls with epoxy concrete. Overlay as required.
A11B	4,982 (53,625)	114 (4.5)	152 (6.0)	191 (7.5)	Remove, clean, and replace old joint sealant with high quality joint sealant[3]. Clean medium- and low-severity cracks and seal with high quality crack sealant[3]. Replace shattered slab. Partial- or full-depth patching is required to repair spalls. Overlay as required.

(Sheet 4 of 5)

Table 3-2
(Concluded)

Feature	Area sq m (sq ft)	Overlay Requirements, mm (in.)[1]			Maintenance and Repair Alternatives for Existing Surfaces
		AC	PCC (Partially Bonded)	PCC (Unbonded)	
Compass Swing Base Apron					
A12B	1,089 (10,000)	102 (4.0)	152 (6.0)	152 (6.0)	Remove, clean, and replace old joint sealant with high quality joint sealant[3]. Clean and repair spalls with epoxy concrete. Overlay as required.
Avum Hangar Apron					
A13B	---------	0.0	0.0	0.0	Clean low-severity cracks and seal with high quality crack sealant[3]. Clean cracks around patches and seal with high quality crack sealant[3]. Partial-depth patching or epoxy concrete should be used to repair spalls.

(Sheet 5 of 5)

Table 3-3
Maintenance, Repair, and Construction Alternatives for Airfield Pavements, Rigid

	Maintenance				Repair											Construction	
Distress Type	Seal Minor Cracks	Joint Seal	Partial Patch	Epoxy Patch	Seal Major Cracks	Full-Depth Patch	Under Sealing	Slab Grinding	Surface Milling	AC Overlay	PCC Overlay	Slab Replacement	Crack & Seat with AC Structural Overlay[1]	AC Overlay w/Geotextile	Repair/Install Surface/Subsurface Drainage System	PCC Recycling	Remove Existing PCC and Reconstruct
Blowup			L,M			M,H						H					
Corner break	L			M,H	M,H	M,H						H					
Longitudinal/transverse/ diagonal cracking	L,M				M,H					H	H	H	M,H	H	L,M,H	H	H
D cracking	L		M,H		M,H	H						H				H	H
Joint seal damage		M,H															
Patching (small) <5 ft²	L,M		M	L,M	M,H	M,H						H					
Patching/utility cut	L,M		M	L,M	M,H	M,H						H					H
Popouts[2]				A						A	A						
Pumping	A	A			A		A								A		
Scaling/map cracking			M,H					M,H		M,H	M,H						
Fault/settlement		L,M					M,H	L,M	M,H						L,M,H		
Shattered slab	L				L,M					M,H	M,H	M,H		H	L,M,H	H	H
Shrinkage crack[3]																	
Spalling (joints)		L	L,M	L,M,H	M,H	M,H											
Spalling (corner)			L,M	L,M	M,H	M,H											

Note: L = low-severity level; M = medium-severity level; H = high-severity level; A = no severity levels for this distress.
[1] Drainage facilities to be repaired as needed.
[2] Popouts normally do not require maintenance.
[3] Shrinkage cracks normally do not require maintenance.

Table 3-4
Maintenance, Repair, and Construction Alternatives for Airfield Pavements, Flexible

Distress Type	Maintenance				Repair												Construction		
	Seal Minor Cracks	Repair Potholes	Partial-Depth Patching	Apply Rejuvenators[1]	Seal Major Cracks	Full-Depth Patching	Surface Treatment[2]	Slurry Seal[3]	Thin AC Overlays[4]	Surface Milling	Grooving	Porous Friction Course	Repair Drainage Facilities[5]	Surface Recycling	AC Structural Overlay[4]	PCC Structural Overlay	Remove Existing Surface and Reconstruct	Hot Recycle	Cold Recycle
Alligator cracking	L	M,H	M			M,H	L	L					L,M,H		M,H	M,H	H		
Bleeding										L,M				M,H			H	M,H	M,H
Block cracking	L,M			L	M,H		L,M	L						M	M,H			M,H	M,H
Corrugation			L,M			L,M,H			M,H	L,M							M,H		
Depression			L,M,H			M,H			M,H				L,M,H				H		
Jet blast				A		A			A										
Reflection cracking	L,M				M,H		L,M	L							M,H			H	
Longitudinal and transverse cracking	L,M				M,H		L,M	L							M,H			H	
Oil spillage			A			A			A	A				A			A	A	
Patching	L,M		M		M	M,H									M,H		H	H	
Polished aggregate							A	A	A	A	A	A		A					
Raveling/weathering		M,H		L,M		M	L,M	L	M,H	M				M,H		H	H	M,H	
Rutting			L,M			L,M,H							L,M,H		M,H	H	H	M,H	
Shoving			L			L,M				L,M							M,H	M,H	
Slippage cracking	L		L,M		L,M	M,H									M,H		M,H	M,H	
Swell			L,M			M,H				L,M			L,M,H				H		

Note: L = low-severity level; M = medium-severity level; H = high-severity level; A = no severity levels for this distress.
[1] Not to be used on high speed areas due to increased skid potential.
[2] Not to be used on high-type airfields due to FOD potential.
[3] Not to be used on heavy traffic areas.
[4] Patch distressed areas prior to overlay.
[5] Drainage facilities to be repaired as needed.

4 Conclusions

General

The overlay requirements shown in Table 3-2 were determined based on representative conditions at the time of testing, and the backcalculated modulus values were determined for the various pavement layers and can deviate throughout the year. The backcalculated modulus values were much lower during previous tests conducted during thaw-weakened periods. Therefore, it is recommended that before specific structural improvements are programmed, a thorough pavement analysis and design be completed to select the most cost-effective improvement technique. In planning structural improvements and/or reconstruction requirements, it should be recognized that TM 5-825-1/AFMAN 32-8008, Vol. 1 (Headquarters, Departments of the Army and Air Force, 1994), specifies that PCC be used in numerous airfield areas, such as the ends of all runways, primary taxiways, and primary parking aprons.

The maintenance and rehabilitation alternatives discussed in Chapter 3 and summarized in Table 3-2 should be performed as soon as possible to retain the full benefit of the structural capacity of the existing pavement. The maintenance and repair alternatives suggested were selected from those listed for the various distresses shown in Tables 3-3 and 3-4. In many instances, the performance of a specific alternative is dependent upon local conditions and contractors. Due to the severity of block cracking and weathering on the surfaces of features R1A, T1A, T2A, T5A, A1B, A2B, and A3B, Foreign Object Damage (FOD) is a problem for aircraft operating with engines running. In addition, FOD from the features above has been blown onto the surfaces of all other airfield features by the operation of rotary-wing aircraft.

The operational ACN's for the fixed-wing facilities are 29/R/D/W/T for the rigid pavements and 26/F/C/W/T for the flexible pavement features. The operational ACN's for the rotary-wing facilities are 10/R/C/W/T for the rigid pavements and 10/F/C/W/T for the flexible pavement features.

Structural Capacity and Condition Ratings

Runway 13-31

All features of Runway 13-31 with the exception of R1A are structurally adequate to withstand 20 years of projected day-to-day operations. The ends of all runways are now required to be PCC as opposed to the existing AC type construction. With routine maintenance and repairs, features R2A, R3A, R4A, R5A, and R6A should perform satisfactorily for the 20-year design period. The overrun (R1A) requires reconstruction to withstand 20 years of projected day-to-day operations. The PCN for Runway 13-31 is 40/F/C/W/T. The PCN for the overrun is 7/F/C/W/T.

The general condition rating of Features R2A, R3A, R4A, R5A, R6A is fair to good with the Overrun being rated as failed.

Alpha Lane (Old Runway 4-22)

All features of the Alpha Lane (Old Runway 4-22) require construction to withstand 20 years of projected day-to-day operations. This feature is now closed to fixed-wing traffic and was evaluated for rotary-wing traffic only. The PCN for the Alpha Lane (Old Runway 4-22) is 12/F/C/W/T. The PCN for the overruns is 4/F/C/W/T.

The general condition rating of the Alpha Lane is failed.

Connecting Taxiway, North Taxiway, Midfield Taxiway and Compass Swing Base Taxiway

The Connecting Taxiway and North Taxiway require construction to withstand 20 years of projected day-to-day operations. The Midfield Taxiway requires structural improvement, and the Compass Swing Base Taxiway is structurally adequate to withstand 20 years of projected day-to-day operations. Feature T2A is AC pavement and is now required to be PCC. PCN's for the Connecting Taxiway, North Taxiway, Midfield Taxiway, and Compass Swing Base Taxiway are 5/F/C/W/T, 24/F/C/W/T, 26/R/C/W/T, and 11/F/C/W/T, respectively.

The general condition ratings are failed for the Connecting Taxiway and the North Taxiway, fair for the Midfield Taxiway, and very poor for the Compass Swing Base Taxiway.

Warm-up Aprons

Features A1B and A2B require construction to withstand the projected 20-year traffic. These aprons are now required to be PCC. PCN's for the North Warm-up Apron and the South Warm-up Apron are 11/F/C/W/T and 15/F/C/W/T, respectively.

The general condition rating for the North Warm-up Apron and the South Warm-up Apron is failed.

Hover Lane and Parking Apron

The Hover Lane (A3B) requires construction , and five PCC features on the Parking Apron (A4B, A5B, A6B, A7B, and A8B) require structural improvement to withstand the 20 years of projected traffic. Feature A9B on the Parking Apron is structurally adequate to withstand 20 years of projected day-to-day operations. The PCN's for A3B, A4B, A5B, A6B, A7B, A8B, and A9B are: 12/F/C/W/T, 18/R/C/W/T, 19/R/C/W/T, 19/R/C/W/T, 18/R/C/W/T, 18/R/C/W/T and 29/R/C/W/T, respectively.

The general condition rating of the Hover Lane is failed, and the Parking Apron ratings range from good to excellent.

East and West Rotary Wing Aprons

The rotary wing aprons require structural improvement to withstand the 20 years of projected traffic. The PCN for the East Rotary Wing Apron and the West Rotary Wing Apron is 11/R/D/W/T. The rotary wing aprons were evaluated for 50,000 passes of a 22,680 kg (50,000 lb) CH-47 aircraft.

The general condition rating of the East and West Rotary Wing Aprons is very good.

Compass Swing Base and Avum Hangar Apron

The Compass Swing Base requires structural improvement and the Avum Hangar Apron requires routine maintenance to withstand the 20 years of projected traffic. PCN's for the Compass Swing Base and Avum Hangar Apron are 10/R/C/W/T and 12/R/C/W/T, respectively.

The general condition rating of the Compass Swing Base is very good, and the condition rating of the Avum Hangar Apron is excellent.

Thaw-weakened conditions

During thaw-weakened conditions the controlling PCN's for the main runway (Runway 13-31), the Midfield Taxiway, and the Parking Apron are 22/F/C/W/T, 18/R/D/W/T, and 11/R/D/W/T, respectively. The South Warm-Up Apron and North Taxiway have PCN's of 6/F/D/W/T. The North Warm-Up Apron has a PCN of 4/F/D/W/T. The Connecting Taxiway and the Alpha Lane have a PCN of 2/F/D/W/T. The Compass Swing Base Taxiway and the Hover Lane have a PCN of 3/F/D/W/T. The East and West Rotary Wing Aprons have a PCN of 8/R/D/W/T. The Compass Swing Base Apron and the Avum Hangar Apron have a PCN of 7/R/D/W/T.

Table C1 summarizes the condition ratings for each feature. Table D4 summarizes PCN values for normal and thaw-weakened periods.

References

American Society of Testing and Materials. (1994). "Standard Test Method for Airport Pavement Condition Index Surveys," Designation: D 5340-93, Philadelphia, PA.

Bush Albert J. III. (1986). "Performance Prediction of Low Volume Airfield Pavements," Technical Report GL-86-14, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Headquarters, Department of the Army, (1988). "Air Traffic Control Airspace, Airfields Flight Activities, and Navigational Aids," Army Regulation 95-2, Washington, DC.

________. (1991a). "Surfaced Areas, Bridges, Railroad Track and associated Appurtenances," Army Regulation AR 420-72, Washington, DC.

________. (1991b). "Engineering and Design Aircraft Characteristics for Airfield-Heliport Design and Evaluation," Engineering Technical Letter ETL 1110-3-394, U.S. Army Corps of Engineers, Washington, DC.

Headquarters, Departments of the Army and the Air Force. (1988). "Rigid Pavements for Airfields," Technical Manual TM 5-825-3/ AFM 88-6, Chap.3, Washington, DC.

________. (1993). "Standard Practice for Sealing Joints and Cracks in Rigid and Flexible Pavements," TM 5-822-11/AFP 88-6, Chap. 7, Washington, DC.

________. (1994). "General Provisions for Airfield/Heliport Pavement Design," TM 5-825-1/AFMAN 32-8008, VOL. 1, Washington, DC.

Headquarters, Departments of the Army, the Air Force and the Navy. (1978). "Flexible Pavement Design for Airfields," Design Manual DM 21.3/TM 5-825-2/AFM 88-6, Chap. 2 Washington, DC.

________. (Draft). "Airfield Pavement Evaluation," Technical Manual TM 5-826-1/AFJMAN 32-1036/DM 21.7, Washington, DC.

Webster, Steve L., Grau, Richard H., Williams, Thomas P. (1992). "Description and Application of Dual Mass Dynamic Cone Penetrometer," Instruction Report GL-92-3, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Appendix A Background Data

Description of the Airfield

BAAF is located at Fort Carson, CO, approximately 11.3 km (7 miles) south of Colorado Springs, CO, in El Paso County. In December 1995, the airfield consisted of one AC runway, one old AC runway now used only for rotary wing traffic, three flexible pavement taxiways, one rigid connecting taxiway, one flexible hover lane, four rigid pavement aprons, one rigid compass swing base, and two AC run-up areas.

A layout of the airfield pavements is shown in Figure A1, and pavement feature identifications and locations are shown in Figure A2. Runway 13-31 is 23 m (75 ft) wide and 1,389 m (4,560 ft) long. The Alpha Lane (Old Runway 4-22) is 23 m (75 ft) wide and 701 m (2,300 ft) long.

The airfield is located on gently rolling prairie with sharply rising mountains 9.7 km (6 miles) to 16.1 km (10 miles) west of the airfield. The soils in the area consist of sandy and gravelly materials, with sandy clays and sands predominating. Some aeolian deposits consisting of clayey sandy silt exist in the area. The elevation of the airfield is 1,789 m (5,871 ft). The climatology data used herein was taken from the Airfield Pavement Evaluation and Condition Survey Report, Buckley Air National Guard Base, Colorado, dated November 1976, by the Air Force Civil Engineer Center, Tyndall Air Force Base, FL. The climate is semiarid, while the annual rainfall in the area is about 383 mm (15.1 in.) and the annual snowfall is 515 mm (20.3 in). The maximum and minimum temperatures were 36 and -17°C (96° and 1°F), respectively. Temperature and precipitation data are summarized in Table A1.

Previous Reports

Previous reports pertaining to the airfield facilities are listed below, and pertinent data were extracted from them for use in this evaluation report.

a. U.S. Army Engineer Waterways Experiment Station, "Airfield Pavement Evaluation, Butts Army Airfield, Fort Carson, Colorado," Miscellaneous Paper GL-94-35, August 1994,Vicksburg, MS.

b. U.S. Army Engineer Waterways Experiment Station, "Condition Survey, Butts Army Airfield, Fort Carson, Colorado," Miscellaneous Paper GL-89-23, September 1989, Vicksburg, MS.

c. U.S. Army Engineer Waterways Experiment Station, "Airfield Pavement Evaluation, Butts Army Airfield, Fort Carson, Colorado," Miscellaneous Paper S-85-17, August 1985, Vicksburg, MS.

d. U.S. Army Engineer Waterways Experiment Station, "Airfield Pavement Evaluation, Butts Army Airfield, Fort Carson, Colorado," Miscellaneous Paper S-76-22, November 1976, Vicksburg, MS.

e. U.S. Army Engineer Waterways Experiment Station, "Condition Survey, Butts Army Airfield, Fort Carson, Colorado," Miscellaneous Paper S-72-26, June 1972, Vicksburg, MS.

f. U.S. Army Engineer Division Ohio River, "Pavement Evaluation, Butts Army Airfield, Fort Carson, Colorado," October 1960, Cincinnati, OH.

g. U.S. Army Engineer Waterways Experiment Station, "Army Airfield Pavement Evaluation, Butts Army Airfield, Ft. Carson, Colorado," Technical Report No. 3-466, July 1960, Vicksburg, MS.

Design and Construction History

The original pavements at BAAF were constructed in 1954 and consisted of a steel-plank landing mat runway and hardstands that have since been removed. Upgrading the pavement, including new construction and repair of the existing facilities, was performed at various periods from 1958 through 1991. The hangar apron adjacent to the Alpha Lane (Old Runway 4-22) was constructed in 1958, and Runway 13-31 was constructed in 1959. Runway 13-31 overrun and the Connecting Taxiway (which at the time adjoined the now-removed mat runway) were constructed in 1960. The Alpha Lane (Old Runway 4-22), the Warm-Up Aprons, the Compass Swing Base and taxiway, the Hover Lane, and the 178 mm (7 in.) thick portland cement concrete portion of the Parking Apron were constructed in 1964. The Midfield Taxiway, the 229 mm (9 in.) thick portion of the Parking Apron, and the East and West Rotary-wing Parking Aprons were constructed in 1981. The Avum Hangar Apron was constructed in 1991. Table A2 presents the history of the major construction activities at BAAF. Table A3 contains a summary of the physical property data of the various features. Figure A3 shows typical foundation and pavement sections.

Traffic History

Accurate traffic records for BAAF were unavailable at the time of this evaluation. At the request of the airfield commander the airfield was evaluated for 12,000 operations of a 61,236 kg (135,000 lb) C-130 aircraft. Several features are closed to fixed-wing traffic due to the recommendations of previous airfield evaluations. These facilities (features T1A, T4B, T5A, A10B, A11B, A12B, and A13B) were evaluated for 50,000 passes of a 22,680 kg (50,000 lb) CH-47 rotary-wing aircraft.

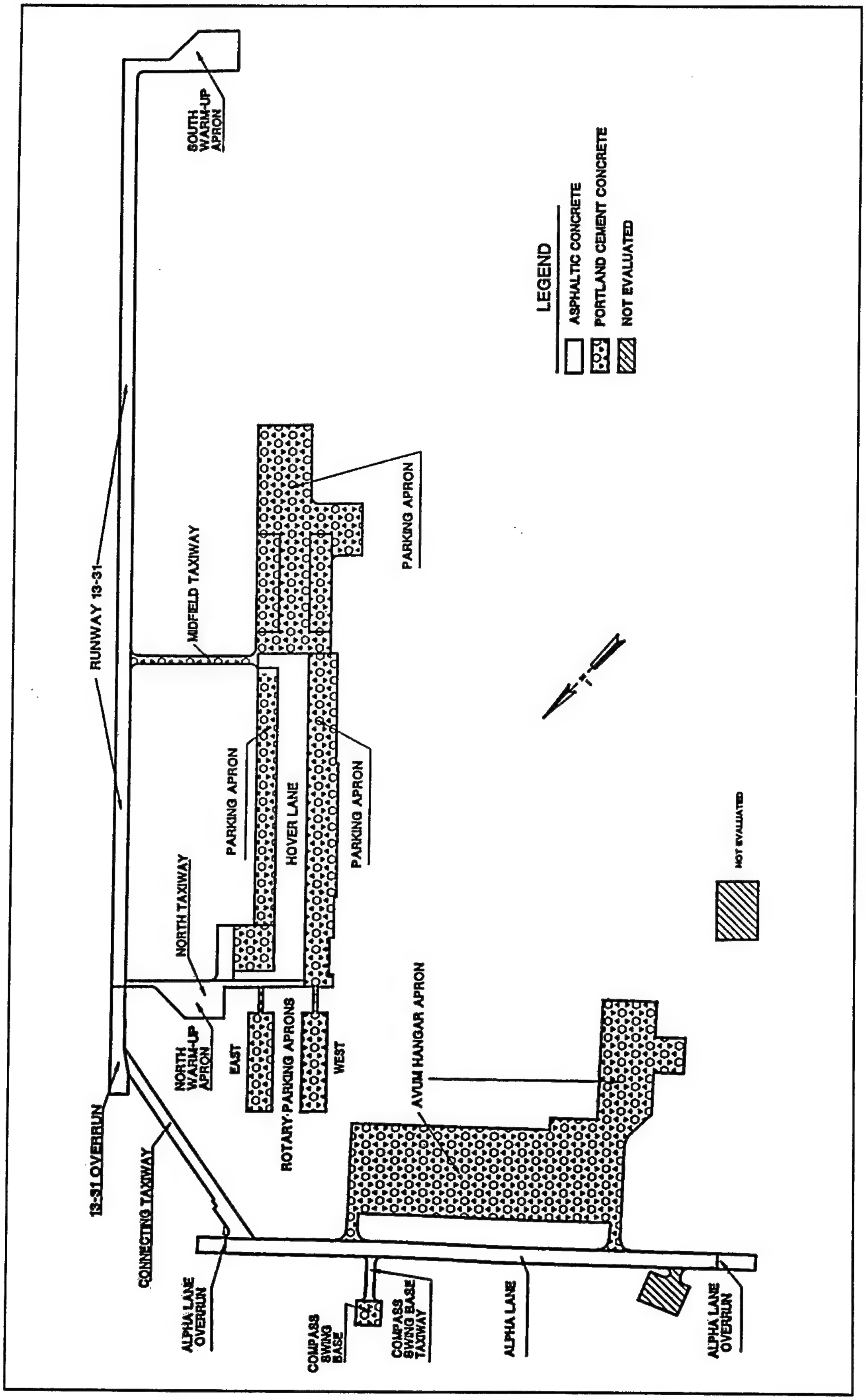


Figure A1. Layout of airfield pavements and facility identifications

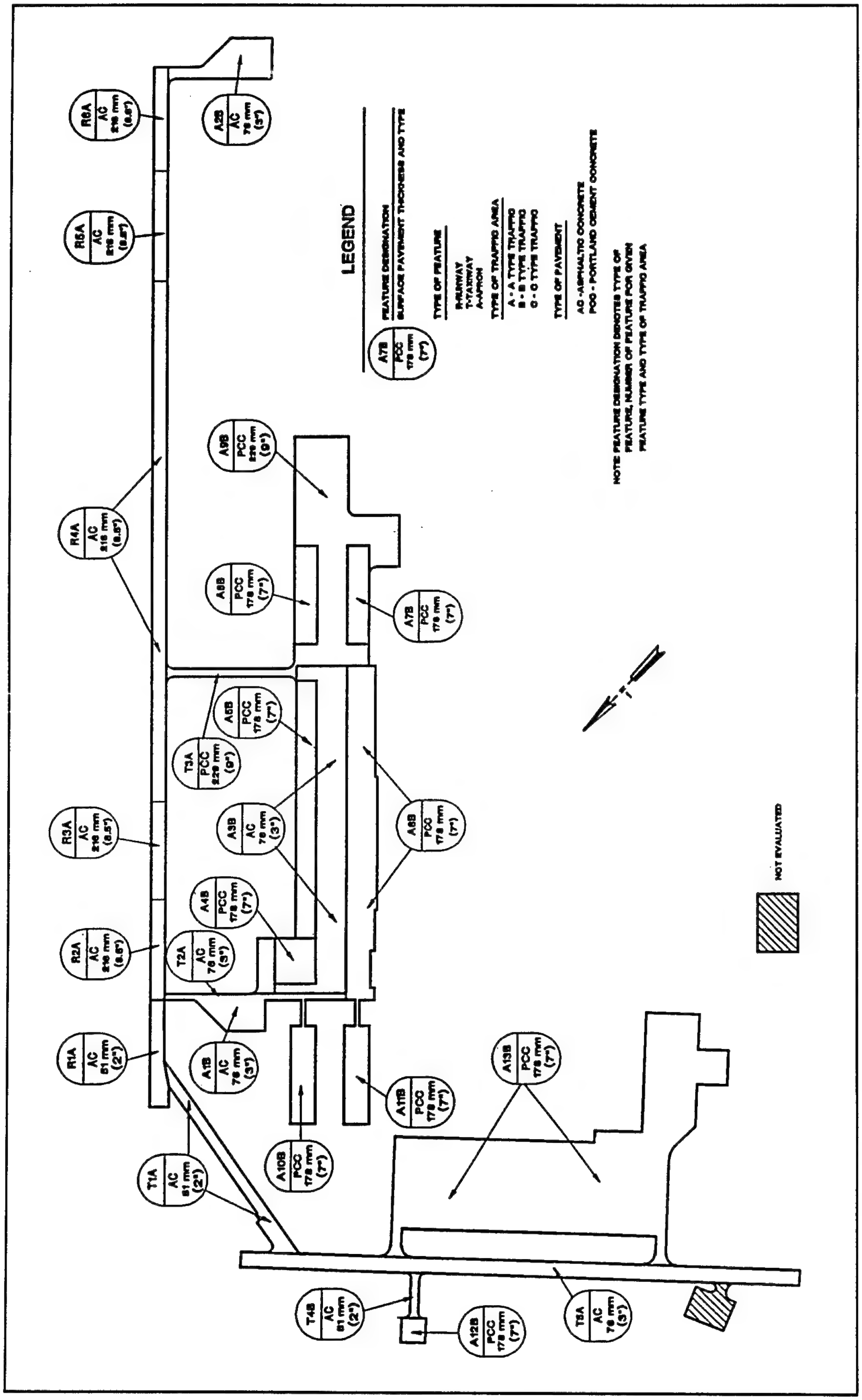


Figure A2. Pavement feature identifications and locations

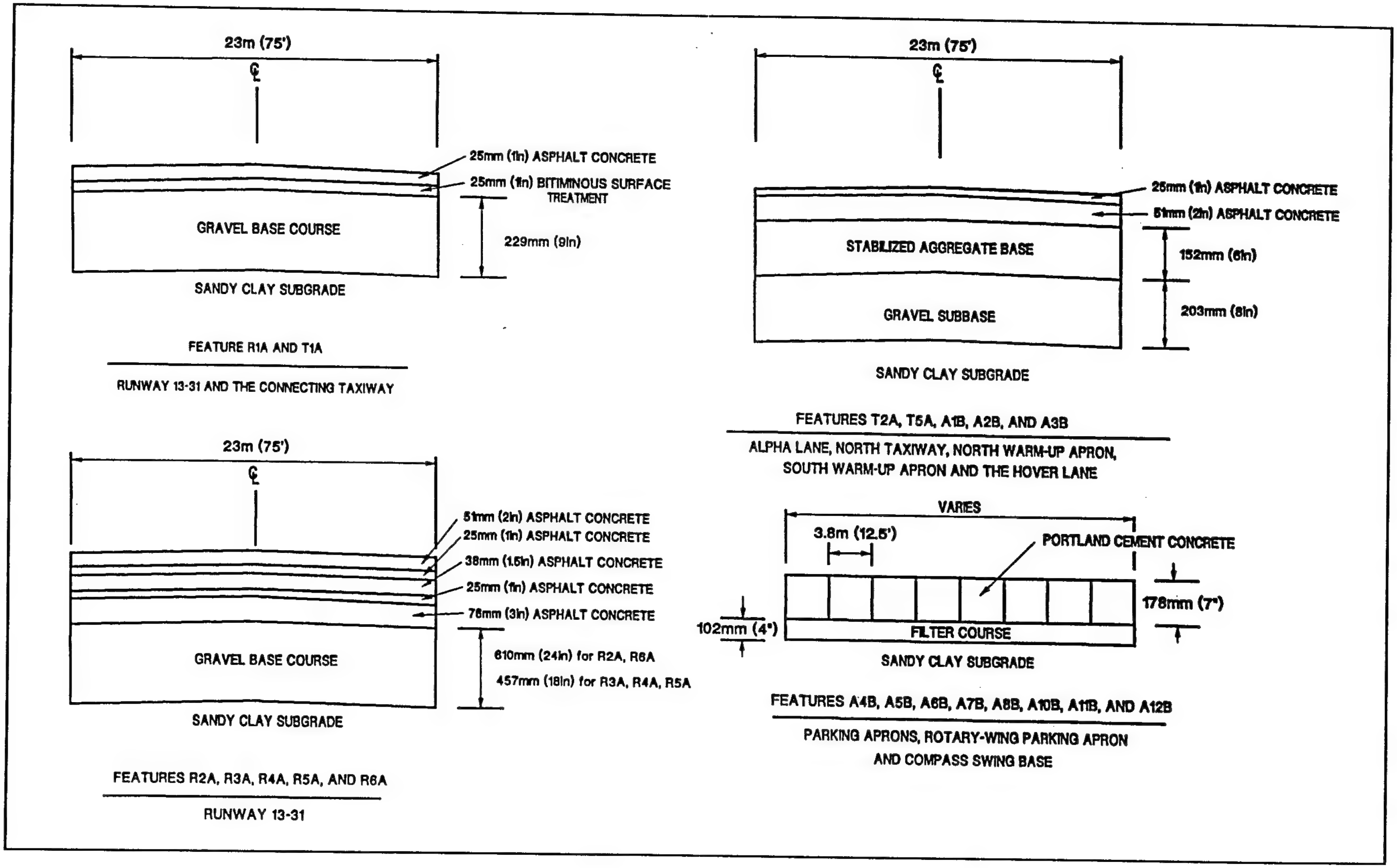


Figure A3. Typical pavement and foundation sections (Continued)

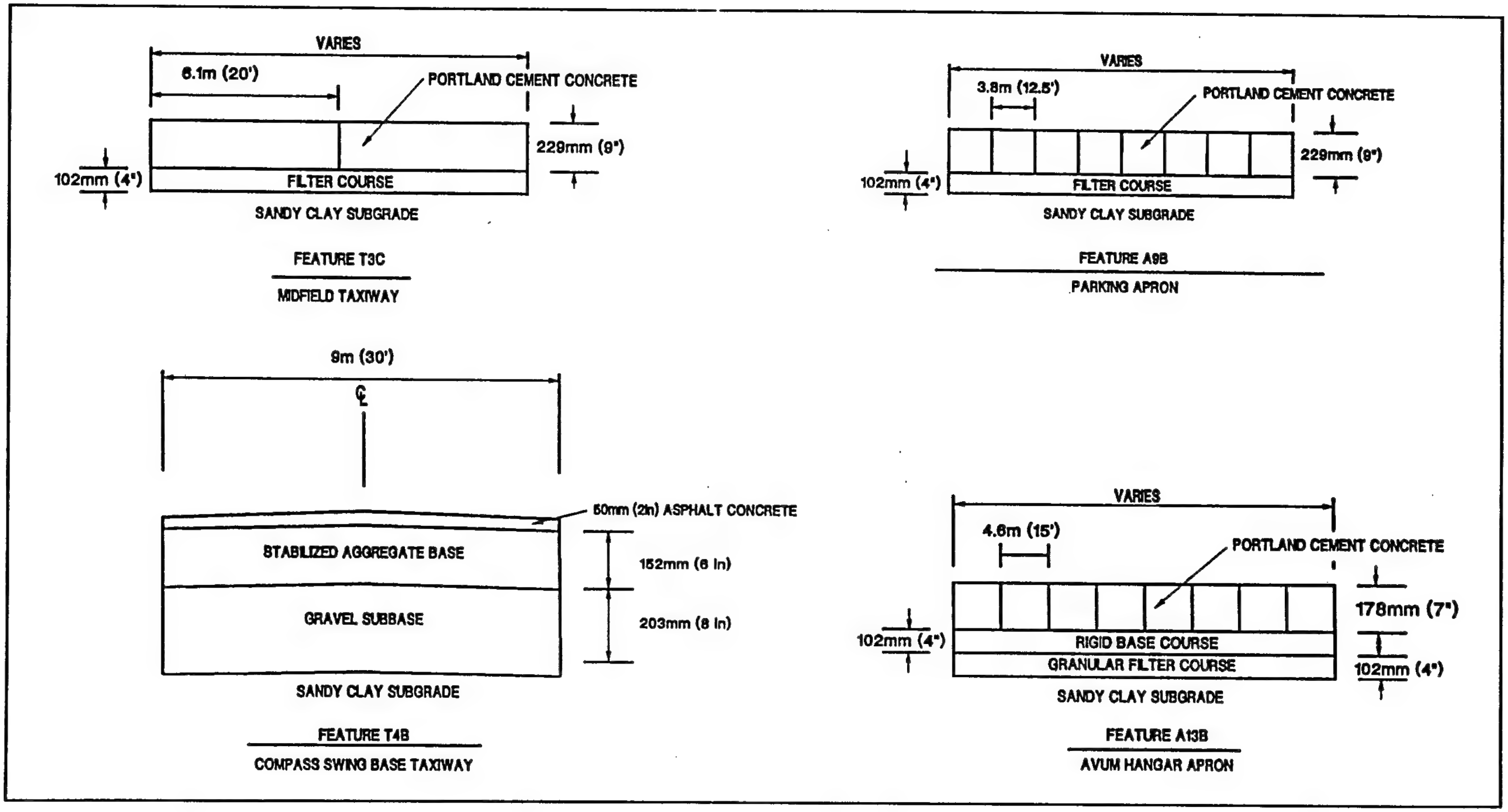


Figure A3. (Concluded)

Table A1
Climatological Data Summary

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature °C/(°F)													
Highest	17 (62)	20 (68)	18 (64)	31 (87)	30 (85)	31 (87)	36 (96)	34 (92)	31 (88)	29 (83)	16 (61)	16 (61)	36 (96)
Mean Daily Max	7 (45)	10 (50)	12 (54)	20 (67)	21 (70)	24 (75)	28 (82)	27 (80)	26 (78)	20 (67)	6 (43)	5 (41)	17 (63)
Mean Daily Min	6 (21)	4 (25)	-1 (30)	3 (37)	7 (45)	10 (50)	13 (55)	12 (53)	8 (47)	3 (38)	-6 (21)	-6 (21)	3 (37)
Lowest	-17 (1)	-8 (17)	-9 (16)	-3 (26)	3 (37)	6 (43)	10 (49)	4 (39)	2 (35)	-5 (23)	-12 (10)	-16 (4)	-17 (1)
Precipitation mm (in.)													
Mean	1 (.06)	0.5 (.02)	60 (2.4)	23 (0.9)	53 (2.1)	99 (3.9)	19 (0.8)	86 (3.4)	3 (.13)	8 (0.3)	19 (.75)	11 (.45)	383 (15.1)
Snowfall mm(in.)													
Mean	30 (1.2)	5 (0.2)	76 (3)	Trace	0	0	0	0	0	0	290 (11.4)	114 (4.5)	515 (20.3)

Table A2
Construction History

Pavement Facility (Feature)	Pavement		Construction Date	Agency[1]
	Thickness, mm (in.)	Type		
Runway 13-31				
R2A, R6A	686(27)[2]	AC	1959	BE
R3A, R4A, R5A	533(21)[2]	AC	1959	BE
R2A, R3A, R4A, R5A, R6A	25(1)[4]	AC	1965	CE
R2A, R3A, R4A, R5A, R6A	38(1.5)[4]	AC	1969	CE
R2A, R3A, R4A, R5A, R6A	25(1)[4]	AC	1973	CE
R2A, R3A, R4A, R5A, R6A	51(2)[4]	AC	1986	CE
Runway 13-31 overrun				
R1A	254(10)[3]	BST[5]	1960	BE
R1A	25(1)[4]	AC	1973	CE
Alpha Lane Taxiway				
T5A-2	406(16)[2]	AC	1964	CE
T5A-2	25(1)[4]	AC	1973	CE
Alpha Lane Overruns				
T5A-1, T5A-3	Unknown	AC	1964	CE
T5A-1, T5A-3	Unknown	AC	1973	CE
Connecting Taxiway				
T1A	254(10)[3]	BST	1960	BE
T1A	25(1)[4]	AC	1973	CE
North Taxiway				
T2A	406(16)[2]	AC	1964	CE
T2A	25(1)[4]	AC	1973	CE
Midfield Taxiway				
T3A	229(9)	PCC	1981	CE
Compass Swing Base Taxiway				
T4B	406(16)[2]	AC	1964	CE
North Warm-up Apron				
A1B	406(16)[2]	AC	1964	CE
A1B	25(1)[4]	AC	1973	CE
South Warm-up Apron				
A2B	406(16)[2]	AC	1964	CE
A2B	25(1)[4]	AC	1973	CE
Hover Lane				
A3B	406(16)[4]	AC	1964	CE
A3B	25(1)[3]	AC	1973	CE
Parking Apron				
A4B, A5B, A6B, A7B	178(7)	PCC	1964	CE
Parking Apron				
A8B	178(7)	PCC	1981	CE

[1] U.S. Army Corps of Engineers.
[2] Thickness includes surface course, base, and subbase.
[3] Bituminous surface treatment and base.
[4] Overlay pavement.
[5] Bituminous surface treatment.
[6] Center 20 m (65 ft) only.

(Sheet 1 of 2)

Table A2
(Concluded)

Pavement Facility (Feature)	Pavement		Construction Date	Agency[1]
	Thickness, mm (in.)	Type		
Parking Apron A9B	229(9)	PCC	1981	CE
Rotary-Wing Parking Apron and Compass Swing Base A10B, A11B, A12B	178(7)	PCC	1981	CE
Avum Hangar Apron A13B	178(7)	PCC	1991	CE

(Sheet 2 of 2)

Table A3
Summary of Physical Property Data

FACILITY				OVERLAY PAVEMENT			PAVEMENT			BASE				SUBBASE			SUBGRADE		
FEATURE	IDENTIFICATION	LENGTH m (FT)	WIDTH m (FT)	THICKNESS mm (IN.)	DESCRIPTION	FLEX. STR. MPa (PSI)	THICKNESS mm (IN.)	DESCRIPTION	FLEX. STR. MPa (PSI)	THICKNESS mm (IN.)	DESCRIPTION	CBR %[1]	K MN/m³ (PSI/IN.)[1]	THICKNESS mm (IN.)	DESCRIPTION	CBR %[1]	DESCRIPTION	CBR %[1]	K MN/m³ (PSI/IN.)[1]
R1A	Runway 13-31 Overrun	152 (500)	23 (75)	25 (1)	AC		25 (1)	Bituminous Surface Treatment		229 (9)	Gravel	80					Sandy Clay (CL)	6	
R2A	Runway 13-31	152 (500)	23 (75)	140[2] (5.5)	AC		76 (3)	AC		610 (24)	Gravel	50					Sandy Clay (CL)	6	
R3A	Runway 13-31	152 (500)	23 (75)	140[2] (5.5)	AC		76 (3)	AC		457 (18)	Gravel	50					Sandy Clay (CL)	6	
R4A	Runway 13-31	780 (2,560)	23 (75)	140[2] (5.5)	AC		76 (3)	AC		457 (18)	Gravel	50					Sandy Clay (CL)	6	
R5A	Runway 13-31	152 (500)	23 (75)	140[2] (5.5)	AC		76 (3)	AC		457 (18)	Gravel	50					Sandy Clay (CL)	6	
R6A	Runway 13-31	152 (500)	23 (75)	140[2] (5.5)	AC		76 (3)	AC		610 (24)	Gravel	50					Sandy Clay (CL)	6	
T5A Sec 1	Alpha Lane Overrun	60 (200)	23 (75)	25 (1)	AC		51 (2)	AC		152 (6)	Stabilized Aggregate	45		203 (8)	Gravel	25	Sandy Clay (CL)	6	

[1] Values from original construction data.
[2] Denotes combined overlays.

(Sheet 1 of 4)

Table A3 (Continued)

FACILITY				OVERLAY PAVEMENT			PAVEMENT			BASE				SUBBASE			SUBGRADE		
FEATURE	IDENTIFICATION	LENGTH m (FT)	WIDTH m (FT)	THICKNESS mm (IN.)	DESCRIPTION	FLEX. STR. MPa (PSI)	THICKNESS mm (IN.)	DESCRIPTION	FLEX. STR. MPa (PSI)	THICKNESS mm (IN.)	DESCRIPTION	CBR %[1]	K MN/m³ (PSI/IN.)[1]	THICKNESS mm (IN.)	DESCRIPTION	CBR %[1]	DESCRIPTION	CBR %[1]	K MN/m³ (PSI/IN.)[1]
T5A Sec 2	Alpha Lane	701 (2,300)	23 (75)	25 (1)	AC		51 (2)	AC		152 (6)	Stabilized Aggregate	45		203 (8)	Gravel	25	Sandy Clay (CL)	6	
T5A Sec 3	Alpha Lane Overrun	60 (200)	23 (75)	25 (1)	AC		51 (2)	AC		152 (6)	Stabilized Aggregate	45		203 (8)	Gravel (GP-GM)	25	Sandy Clay (CL)	6	
T1A	Connecting Taxiway	320 (1,050)	15 (50)	25 (1)	AC		25 (1)	Bituminous Surface Treatment		229 (9)	Gravel	50					Sandy Clay (CL)	6	
T2A	North Taxiway	225 (737)	12 (40)	25 (1)	AC		51 (2)	AC		152 (6)	Stabilized Aggregate	45		203 (8)	Gravel	25	Sandy Clay (CL)	6	
T3A	Midfield Taxiway	191 (627)	12 (40)				229 (9)	PCC		102 (4)	Filter Course		27(100)				Sandy Clay (CL)		27(100)
T4B	Compass Swing Base Taxiway	64 (210)	12 (40)				51 (2)	AC		152 (6)	Stabilized Aggregate			203 (8)	Gravel	25	Sandy Clay (CL)	6	
A1B	North Warm-up Apron			25 (1)	AC		51 (2)	AC		152 (6)	Stabilized Aggregate			203 (8)	Gravel	25	Sandy Clay (CL)	6	
A2B	South Warm-up Apron			25 (1)	AC		51 (2)	AC		152 (6)	Stabilized Aggregate			203 (8)	Gravel	25	Sandy Clay (CL)	6	

(Sheet 2 of 4)

Table A3 (Continued)

FEATURE	FACILITY IDENTIFICATION	FACILITY LENGTH m (FT)	FACILITY WIDTH m (FT)	OVERLAY PAVEMENT THICKNESS mm (IN.)	OVERLAY PAVEMENT DESCRIPTION	OVERLAY PAVEMENT FLEX. STR. MPa (PSI)	PAVEMENT THICKNESS mm (IN.)	PAVEMENT DESCRIPTION	PAVEMENT FLEX. STR. MPa (PSI)	BASE THICKNESS mm (IN.)	BASE DESCRIPTION	BASE CBR %[1]	BASE K MN/m³ (PSI/IN.)[1]	SUBBASE THICKNESS mm (IN.)	SUBBASE DESCRIPTION	SUBBASE CBR %[1]	SUBGRADE DESCRIPTION	SUBGRADE CBR %[1]	SUBGRADE K MN/m³ (PSI/IN.)[1]
A3B	Hover Lane			25 (1)	AC[3]		51 (2)	AC		152 (6)	Stabilized Aggregate			203 (8)	Gravel	25	Sandy Clay (CL)	6	
A4B	Parking Apron	68 (225)	59 (193)				178 (7)	PCC	4.1 (600)	102 (4)	Filter Course		27(100)				Sandy Clay (CL)		27(100)
A5B	Parking Apron	376 (1,235)	33 (110)				178 (7)	PCC	4.1 (600)	102 (4)	Filter Course		27(100)				Sandy Clay (CL)		27(100)
A6B	Parking Apron						178 (7)	PCC	4.1 (600)	102 (4)	Filter Course		27(100)				Sandy Clay (CL)		27(100)
A7B	Parking Apron	149 (487.5)	33 (110)				178 (7)	PCC	4.1 (600)	102 (4)	Filter Course		27(100)				Sandy Clay (CL)		27(100)
A8B	Parking Apron	149 (487.5)	33 (110)				178 (7)	PCC	4.1 (600)	102 (4)	Filter Course		27(100)				Sandy Clay (CL)		27(100)
A9B	Parking Apron						229 (9)	PCC		102 (4)	Filter Course		27 (100)				Sandy Clay (CL)		27 (100)

[3] Placed in the center 20m (65ft) only.

(Sheet 3 of 4)

Table A3 (Concluded)

FACILITY				OVERLAY PAVEMENT			PAVEMENT			BASE				SUBBASE			SUBGRADE		
FEATURE	IDENTIFICATION	LENGTH m (FT)	WIDTH m (FT)	THICKNESS mm (IN.)	DESCRIPTION	FLEX. STR. MPa (PSI)	THICKNESS mm (IN.)	DESCRIPTION	FLEX. STR. MPa (PSI)	THICKNESS mm (IN.)	DESCRIPTION	CBR %[1]	K MN/m^3 (PSI/IN.)[1]	THICKNESS mm (IN.)	DESCRIPTION	CBR %[1]	DESCRIPTION	CBR %[1]	K MN/m^3 (PSI/IN.)[1]
A10B	East Rotary Wing Parking Apron	149 (487.5)	33 (110)				178 (7)	PCC	4.1 (600)	102 (4)	Filter Course		27 (100)				Sandy Clay (CL)		27 (100)
A11B	West Rotary Wing Parking Apron	149 (487.5)	33 (110)				178 (7)	PCC	4.1 (600)	102 (4)	Filter Course		27 (100)				Sandy Clay (CL)		27 (100)
A12B	Compass Swing-Base	30 (100)	30 (100)				178 (7)	PCC	4.1 (600)	102 (4)	Filter Course		27 (100)				Sandy Clay (CL)		27 (100)
A13B	Avum Hangar Apron						178 (7)	PCC		102 (4)	Rigid Base Course			102 (4)	Granular Filter Course		Sandy Clay (CL)		27 (100)

(Sheet 4 of 4)

Appendix B
Tests and Results

Tests Conducted

The pavements were evaluated based on the results from the following physical tests: (a) nondestructive testing utilizing a heavy weight deflectometer (HWD) and (b) dynamic cone penetrometer (DCP) tests. The test procedures and results are discussed below.

Nondestructive Tests

Test equipment

Nondestructive tests (NDT) were performed on the pavements with the Dynatest model 8081 HWD. The HWD is an impact load device that applies a single-impulse transient load of approximately 25 to 30 millisecond duration. With this trailer-mounted device, a dynamic force is applied to the pavement surface by dropping a weight onto a set of rubber cushions which results in an impulse loading on an underlying 30 cm (11.8 in.) diameter circular plate placed on the pavement surface. The applied force and the pavement deflections are measured with load cells and velocity transducers, respectively. The drop height of the weights can be varied from 0 to 39.9 cm (15.7 in.) to produce a force from 30 kN (6,500 lb) to approximately 240 kN (54,000 lb). The system is controlled with a microcomputer which also records the output data. Velocities were measured and deflections computed at the center of the load plate (D1) and at distances of 30 (12), 61 (24), 91 (36), 122 (48), 152 (60), and 183 cm (72) in. (D2 - D7) from the center of the load plate in order to obtain deflection basin measurements.

Test procedure

On runways and taxiways, deflection basin measurements were made at 30m (100 ft) intervals on alternate sides of the centerline along the main gear wheel

paths. For flexible pavements, the tests were performed on two 3 to 4 m (10 to 12 ft) offsets from the center line. For rigid pavements, the tests were conducted at the center of the slab or on the largest unbroken piece. The parking aprons, warm-up aprons, and engine run-up area were tested in a grid pattern of approximately 30.1 m (100-ft) intervals or at locations that were selected to ensure that adequate NDT were performed per feature for evaluation purposes. Lines along which the NDT were conducted or locations tested (specified by number) on each pavement facility are indicated in Figure B1. At each test location, pavement deflection measurements were recorded at force levels of approximately 10, 15, and 25 kips. Impulse stiffness modulus (ISM) values were then calculated based on the slope (load/deflection) of the plot of impulse load versus the deflection at the first sensor (D1) for the maximum force level.

NDT Analysis

The NDT test results or ISM data for each facility were grouped according to different pavement features. The ISM data within a feature were grouped according to differences in the magnitude of the ISM values and are called sections. Visual evaluation of the ISM data indicated that only one section per feature was needed except for feature T5A which required three sections. Figures B2 through B29 show graphically the ISM test results. A representative basin for each feature was determined in accordance with TM 5-826-1/AFJMAN 32-1036/DM 21.7 (Headquarters, Departments of the Army, the Air Force, and the Navy Draft). Table B1 shows the representative basins for each feature as determined from the NDT.

Representative basins were used to determine section modulus values of the various layers within the pavement structure in each section. The method used for determining the modulus values of the pavement layers is described in TM 5-826-1/AFJMAN 32-1036/DM 21.7. Deflection basins were input into a multi-layered elastic backcalculation program to determine the surface, base, and subgrade modulus values. The program determines a set of modulus values which provides the best fit between a measured deflection basin (NDT) and a computed (theoretical) deflection basin. Table B2 presents a summary of the backcalculated modulus values based on the representative basins for each pavement section.

Modulus values for AC pavements can be determined using three methods: (a) use the surface temperature at the time of testing and the previous 5-day mean air temperature, (b) backcalculate the modulus values using the FWD deflection basins, or (c) determine the design modulus from past temperature data. All three methods of determining the AC modulus are described in TM 5-826-1/ AFJMAN 32-1036/DM 21.7. In an evaluation, pavements are evaluated for a design life of 20 years. Modulus of AC is temperature dependent; therefore, the seasonal variation in temperature is considered by using the design modulus from past temperature data. From the climatological table (Table A1), an average daily maximum temperature of 28 °C (82 °F) and an average daily mean of 21 °C (69 °F) were used in determining the design AC modulus. At a frequency level

of 10 Hz for the runways, the design AC modulus was 2,076 MPa (297,613 psi). An AC modulus of 1,395 MPa (200,000 psi) was assigned to AC layers due to an excellent fit between the measured and theoretical basins. This was done in features in which the temperature-based modulus value reached criteria limits in order to backcalculate accurate base and subgrade modulus values (see Table B2). The design AC modulus along with the backcalculated values for the base, subbase, and subgrade layers were used to determine the structural capacity of the AC pavement features.

Modulus values for PCC pavements can be backcalculated using the FWD deflection basins or a design modulus for the PCC can be assigned. In the evaluation of a rigid pavement, a design modulus is typically used for the PCC layer along with the backcalculated values for the base, subbase, and subgrade layers. The backcalculated PCC modulus values shown in Table B-2 are within or slightly above the default range 17,237 to 48,263 MPa (2,500,000 to 7,000,000 psi) recommended in TM 5-826-1/AFJMAN 32-1036/DM 21.7. This manual also recommends a modulus of 34,474 MPa (5,000,000 psi) for a PCC layer in good condition. Since the PCI rating of each PCC feature was from good to excellent (see Table C1), a design modulus value of 34,474 MPa (5,000,000 psi) was assigned to the PCC layers.

Where mean ISM values (as shown in Table B1) were less than 70 MN/m (400 kips/in), the Low Volume Airfield Pavement Procedure (Bush 1986) computer program (LOW) was used to evaluate the pavements. Features R1A, T1A, A2B, T5A section 1, and T5A section 3 were in this category. ISM and layer thicknesses were input into LOW to determine the equivalent base and subgrade California Bearing Ratio (CBR). Layer thicknesses and respective CBR values were then input into the computer program APE (Computer-Aided Evaluation for Airfield Pavements) to compute the load-carrying capacity (PCN) of the pavements and the overlay thickness requirements.

Dynamic Cone Penetrometer Tests

A DCP soil test device was used to obtain subsurface soil data at representative locations. The DCP is a steel cone attached to the end of a metal rod on the other end of which is located an 8 kg (17.6 lb) sliding drop-hammer. For this investigation, a small hole was cored through the AC or PCC material. The cone of the DCP was then placed on top or near the top of the base and the hammer was then dropped repeatedly to drive the cone through the underlying pavement layers. The material resistance to penetration was recorded in terms of inches penetrated per hammer blow. The California Bearing Ratio (CBR) was then determined based on a correlation and procedure recommended in Webster, Grau, and Williams (1992). DCP tests were performed in the AC and PCC areas of the airfield. The results of the DCP tests are best illustrated on a plot of CBR versus depth for each test location. Results of DCP tests conducted on the airfield pavement are shown in figures B30-B46. The DCP results generally indicate high CBR values ranging from 60 to 100 in the top portion of the subgrade beneath most of the pavement features. The CBR drops drastically

below a depth of 15 to 20 in. to CBR values ranging from 4 to 15. These low subgrade CBR values are consistent with the low backcalculated subgrade moduli.

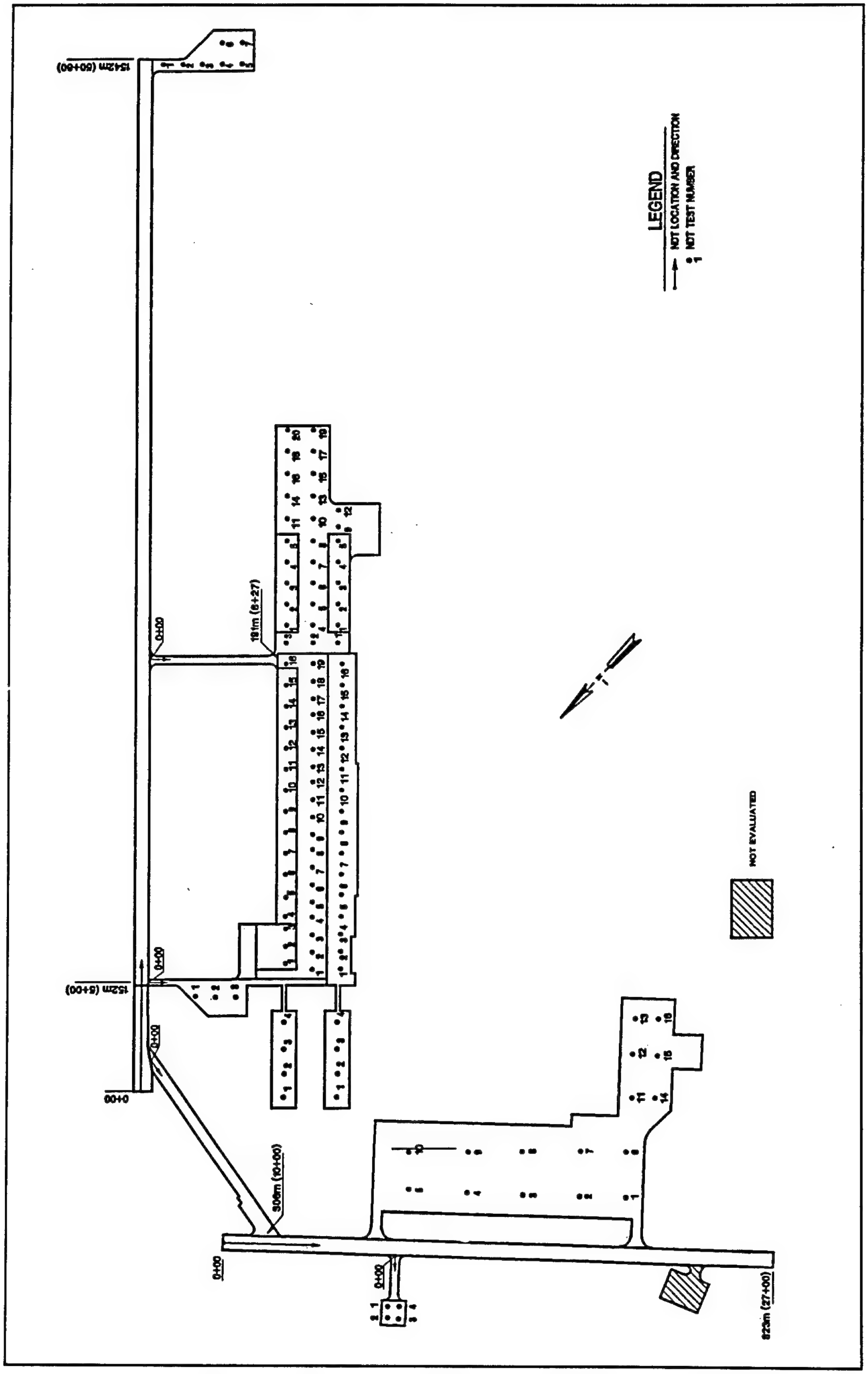


Figure B1. NDT locations and directions

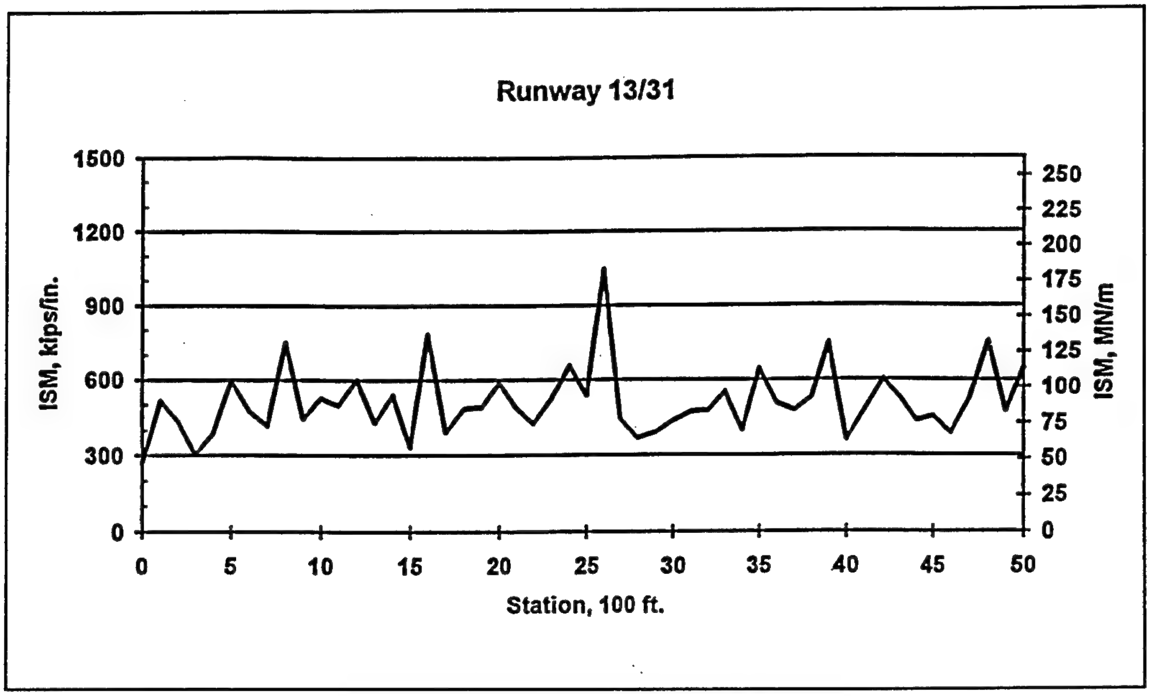


Figure B2. ISM profile for Runway 13-31 (entire length)

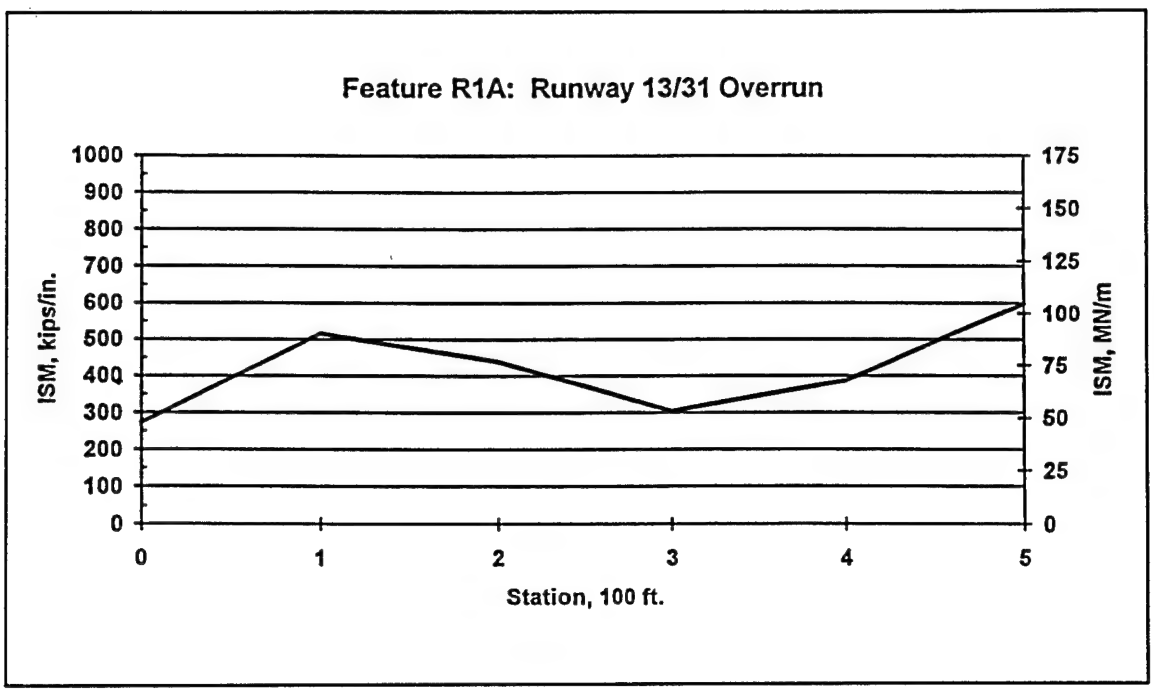


Figure B3. ISM profile for Runway 13-31 Overrun, feature R1A

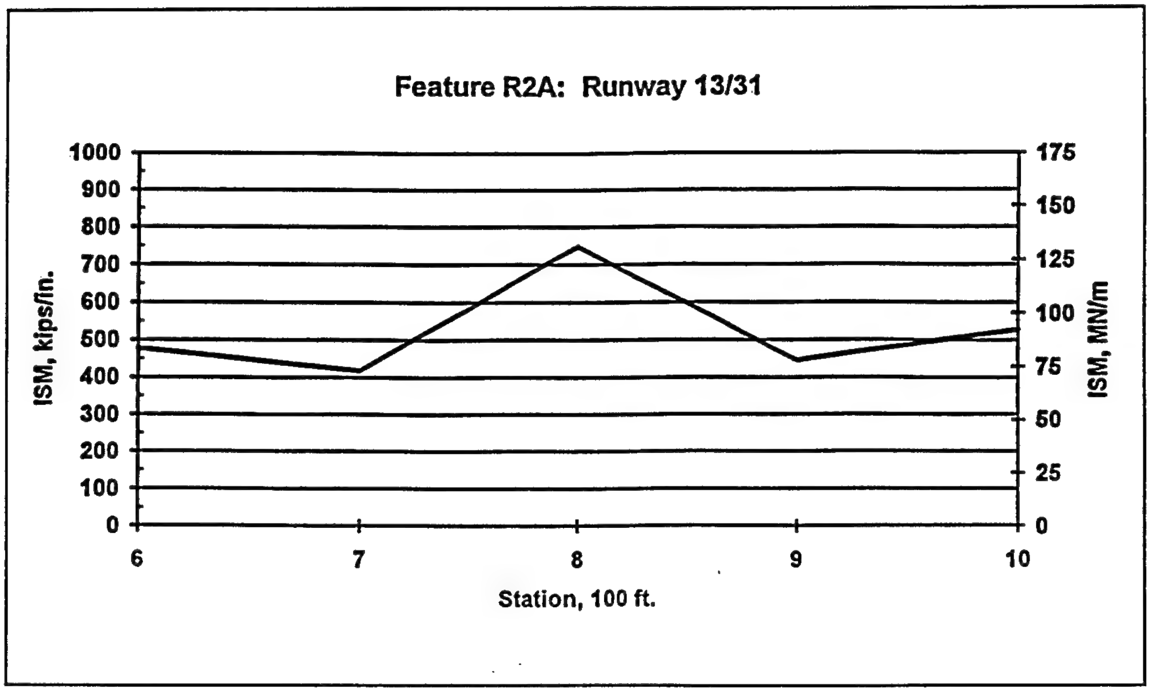


Figure B4. ISM profile for Runway 13-31, feature R2A

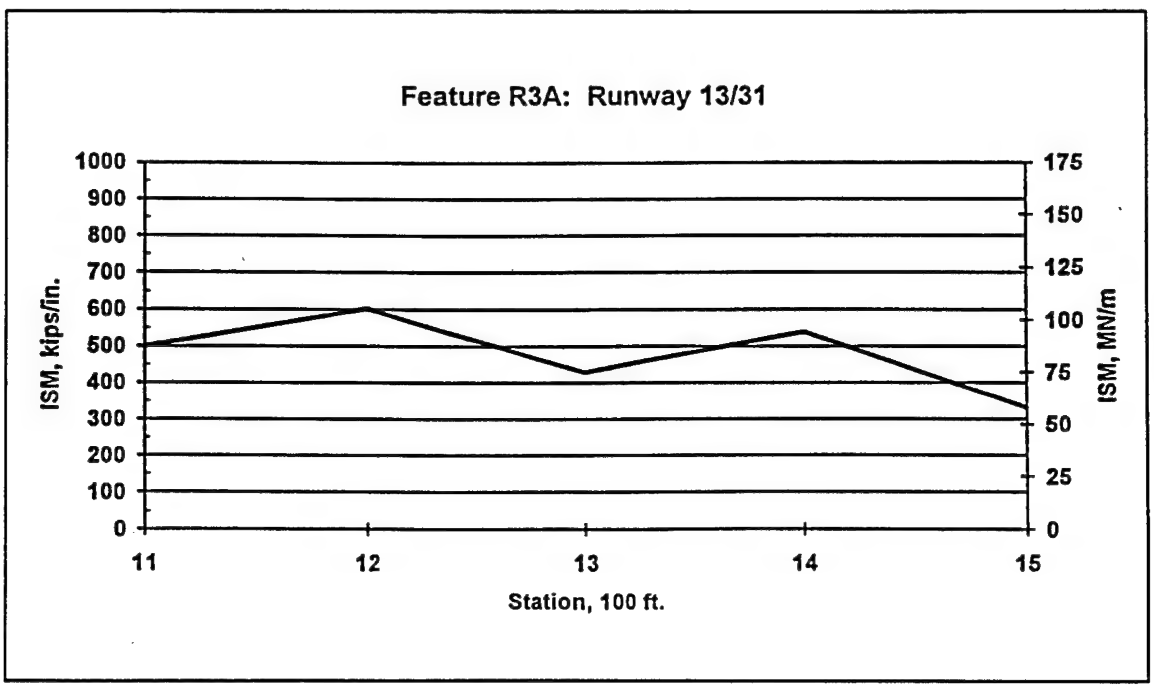


Figure B5. ISM profile for Runway 13-31, feature R3A

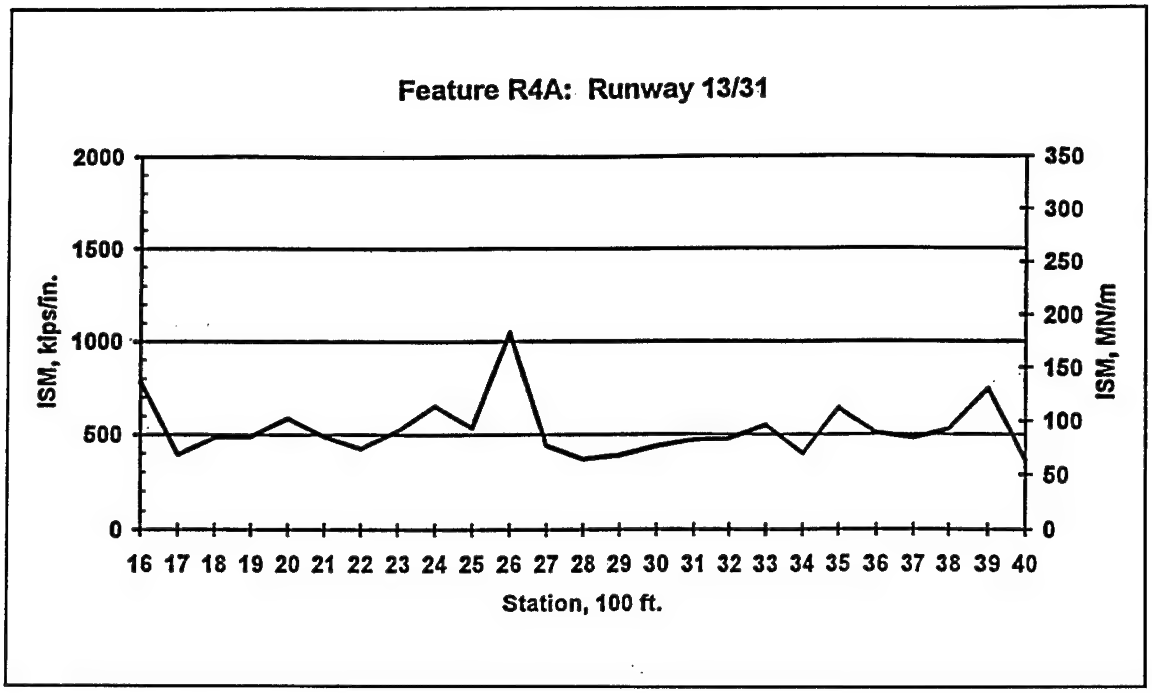


Figure B6. ISM profile for Runway 13-31, feature R4A

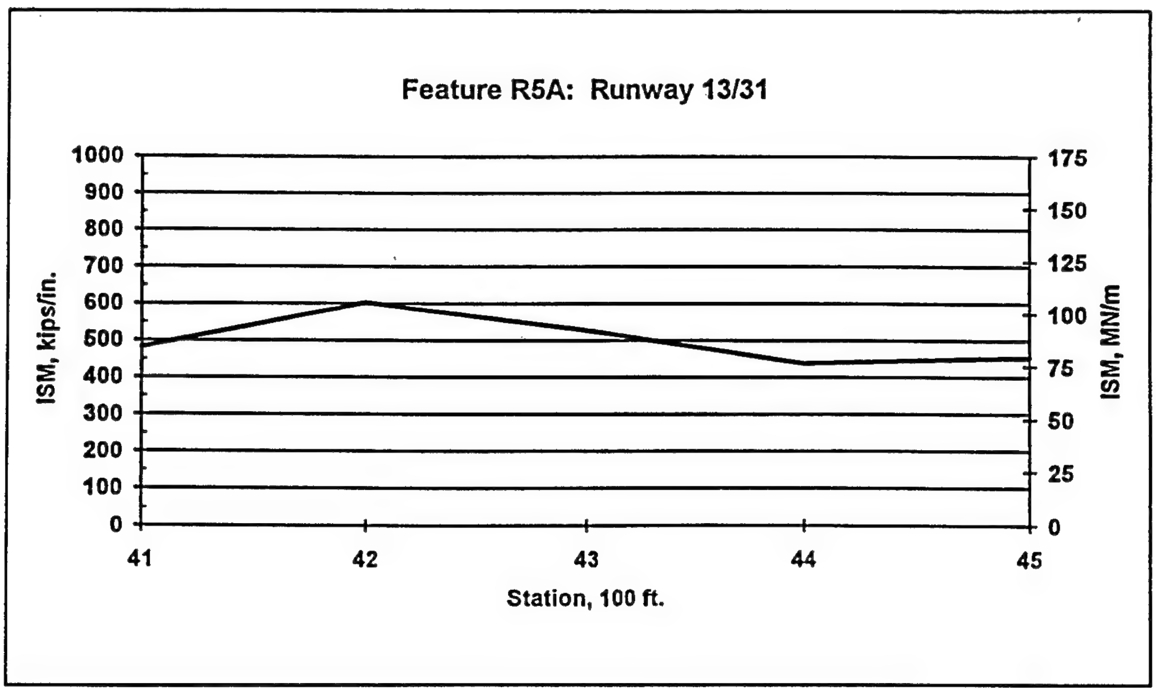


Figure B7. ISM profile for Runway 13-31, feature R5A

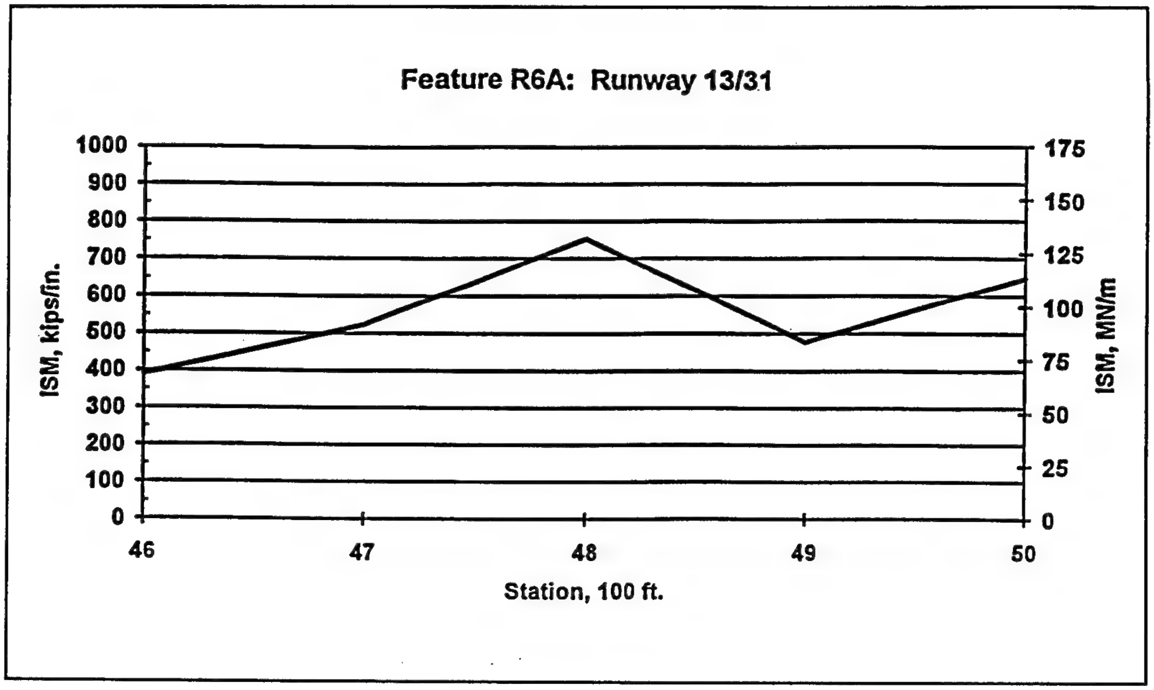


Figure B8. ISM profile for Runway 13-31, feature R6A

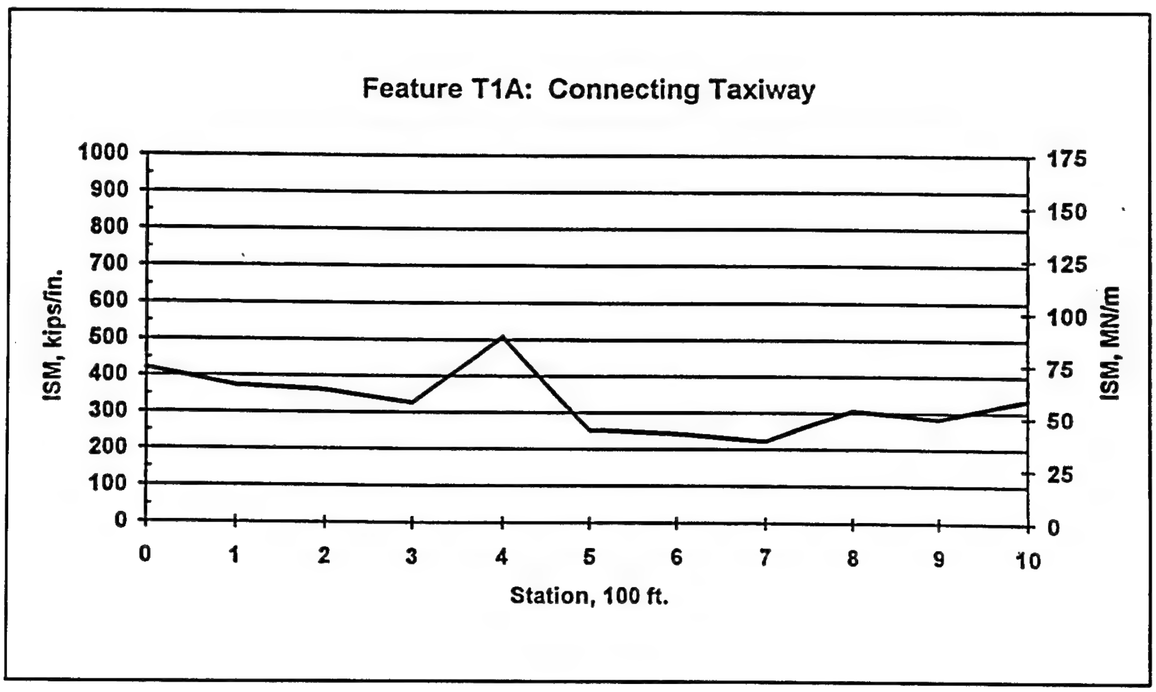


Figure B9. ISM profile for Connecting Taxiway, feature T1A

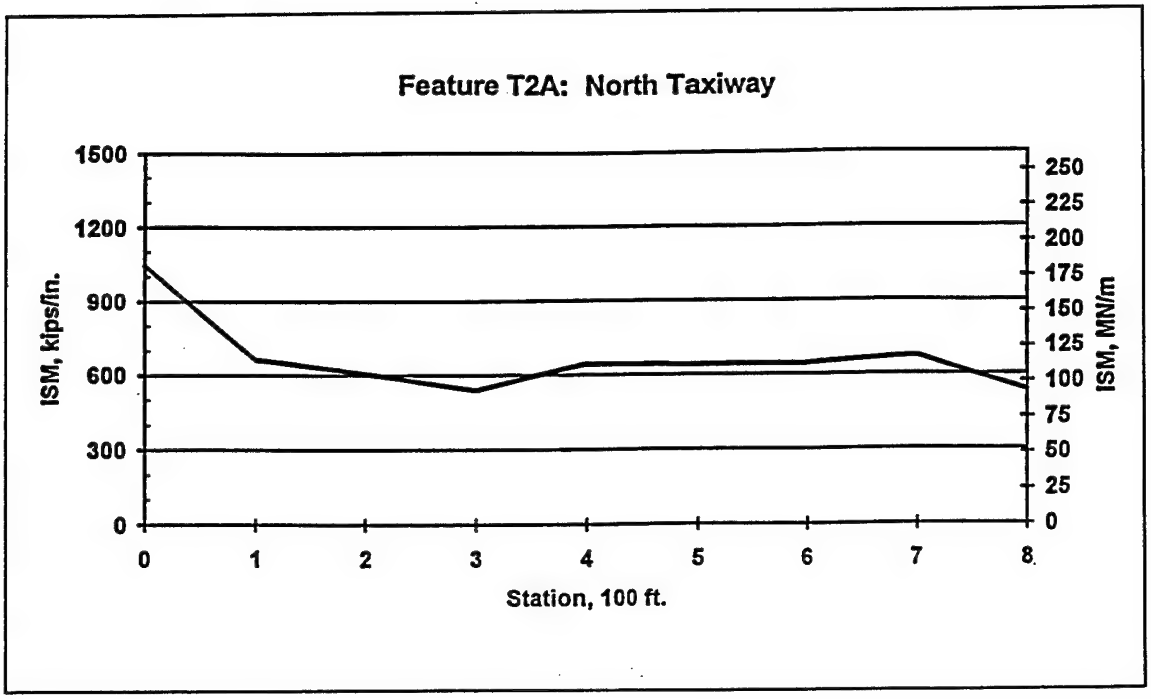


Figure B10. ISM profile for the North Taxiway, feature T2A

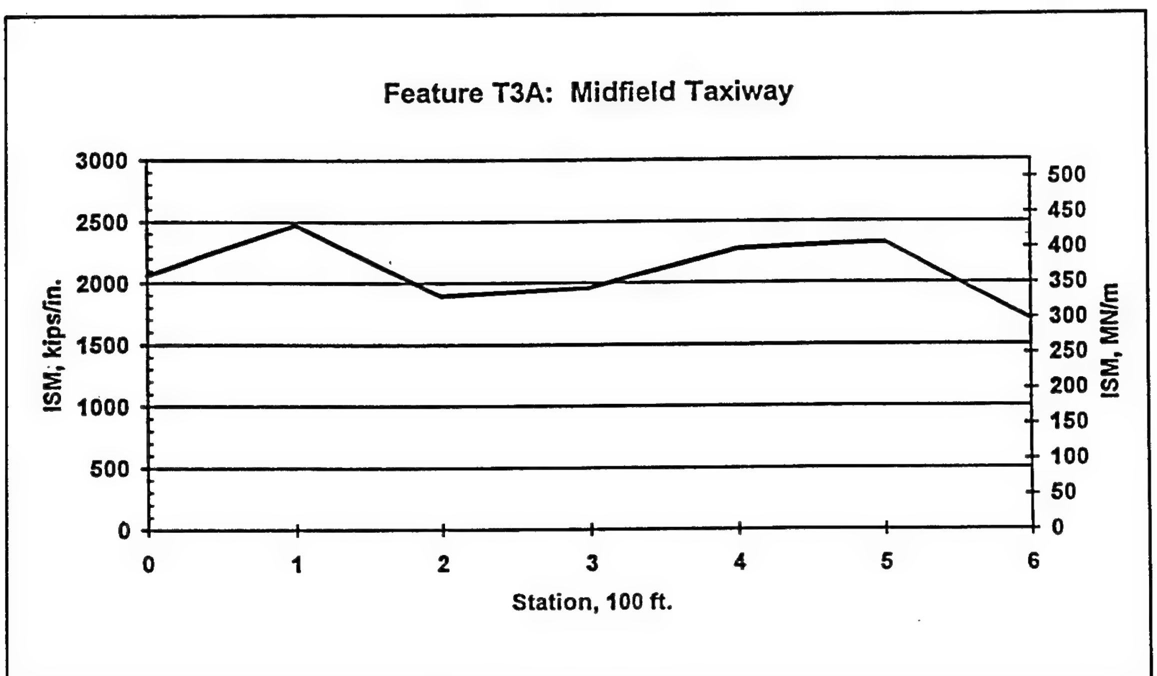


Figure B11. ISM profile for the Midfield Taxiway, feature T3A

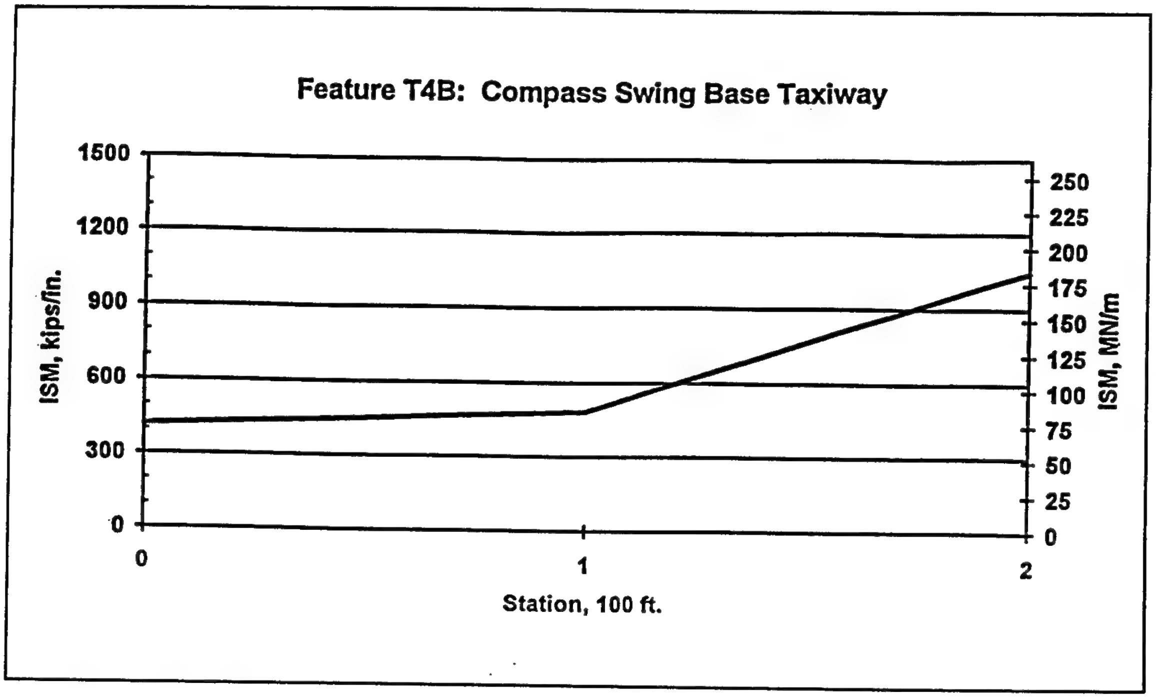


Figure B12. ISM profile for the Compass Swing Base Taxiway, feature T4B

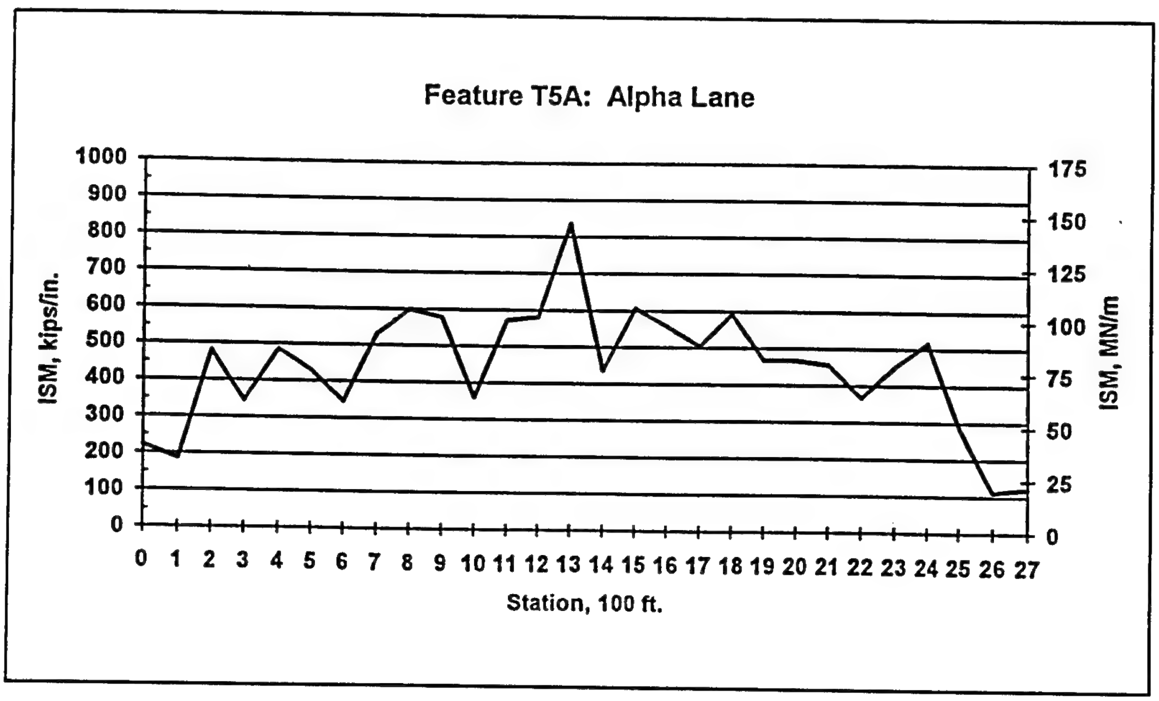


Figure B13. ISM profile for the entire Alpha Lane, feature T5A

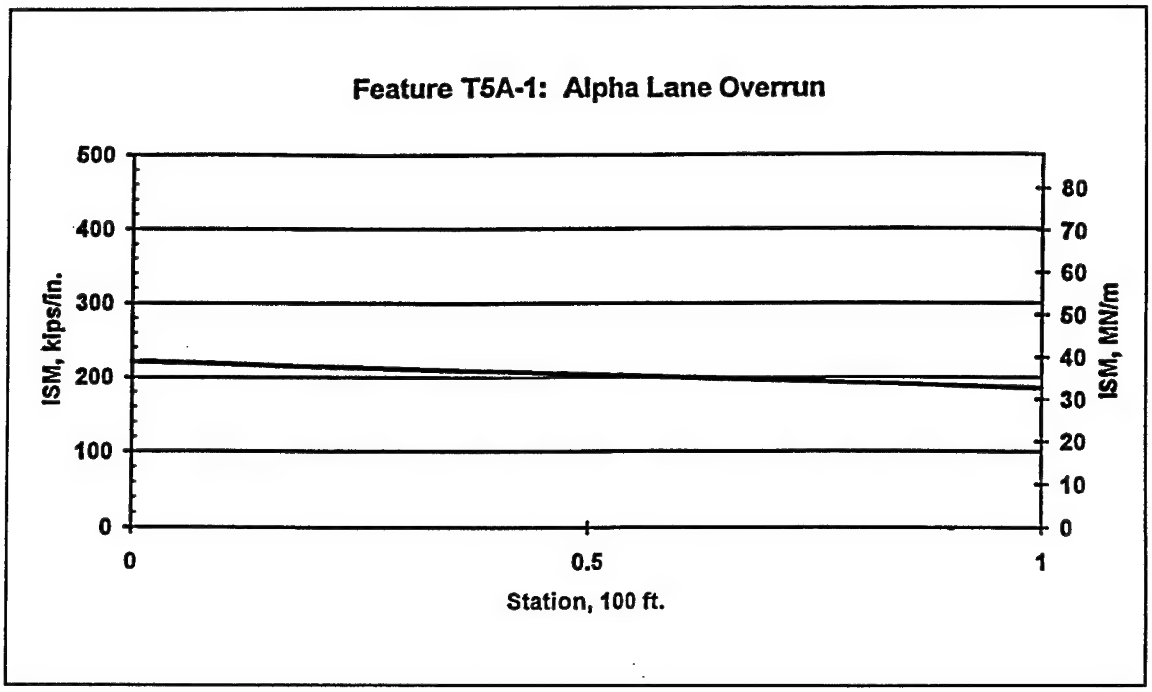


Figure B14. ISM profile for the Alpha Lane Overrun, feature T5A-1

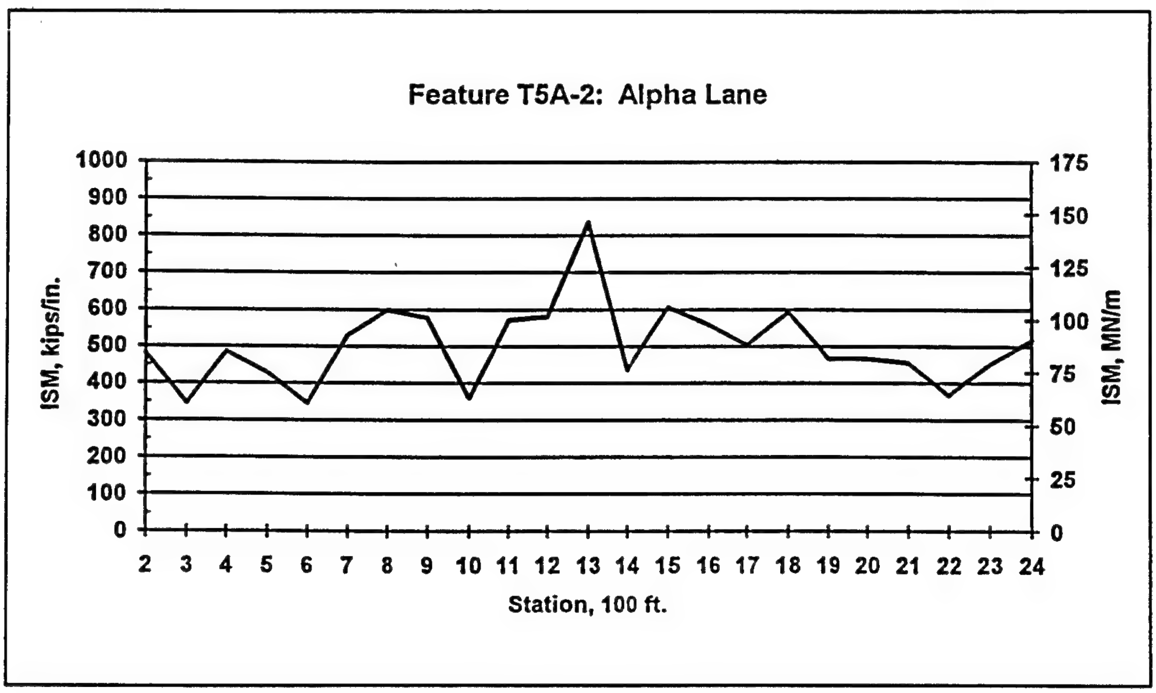


Figure B15. ISM profile for the Alpha Lane, feature T5A-2

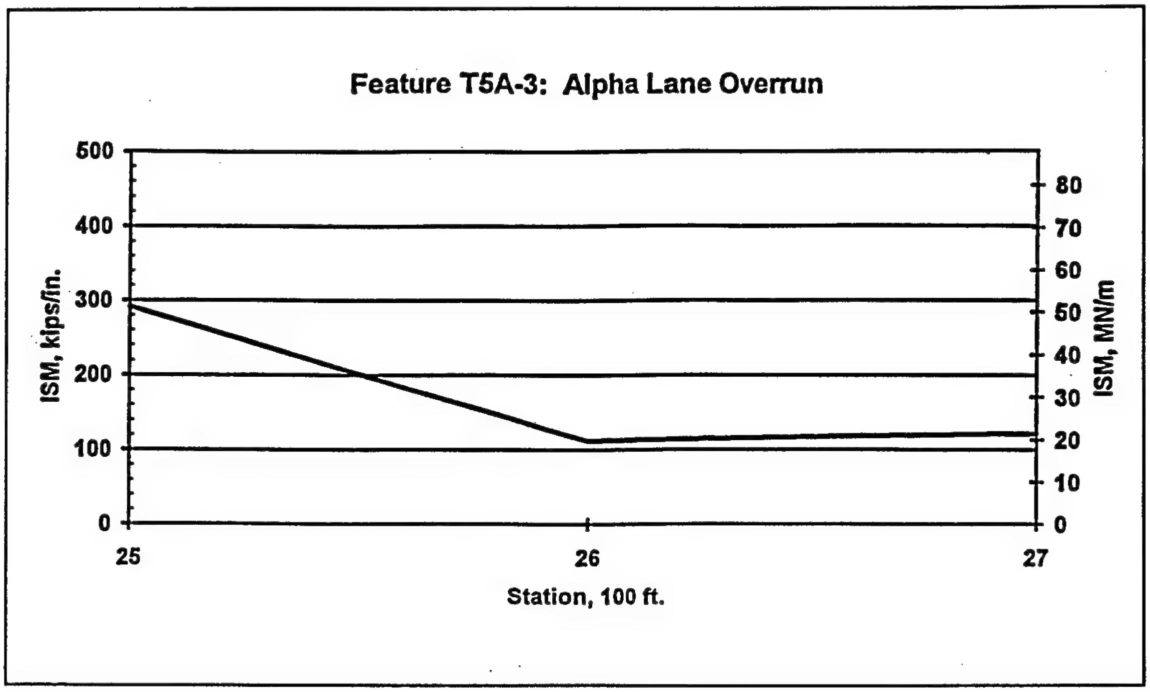


Figure B16. ISM profile for the Alpha Lane Overrun, feature T5A-3

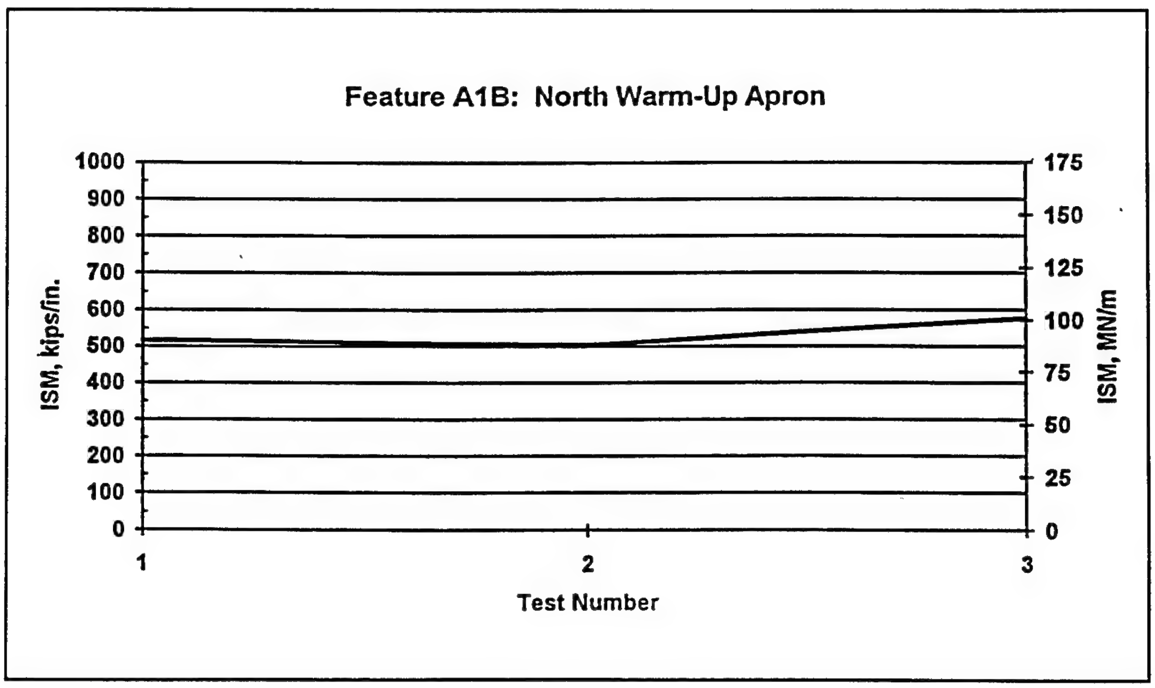


Figure B17. ISM profile for the North Warm-Up Apron, feature A1B

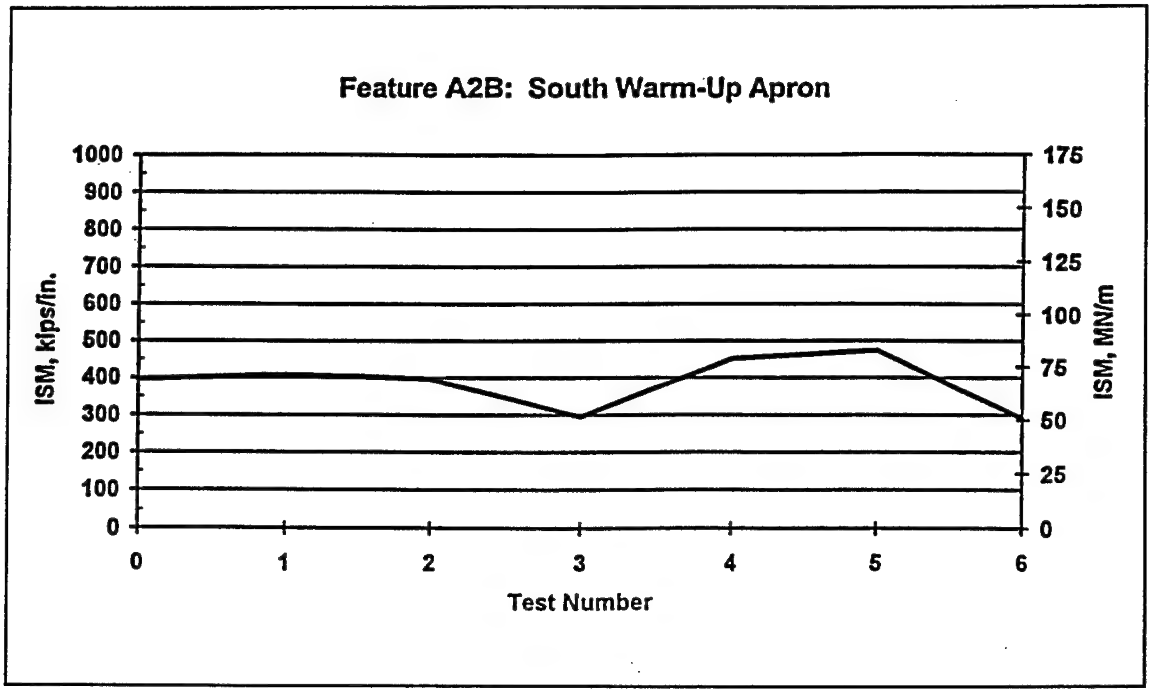


Figure B18. ISM profile for the South Warm-Up Apron, feature A2B

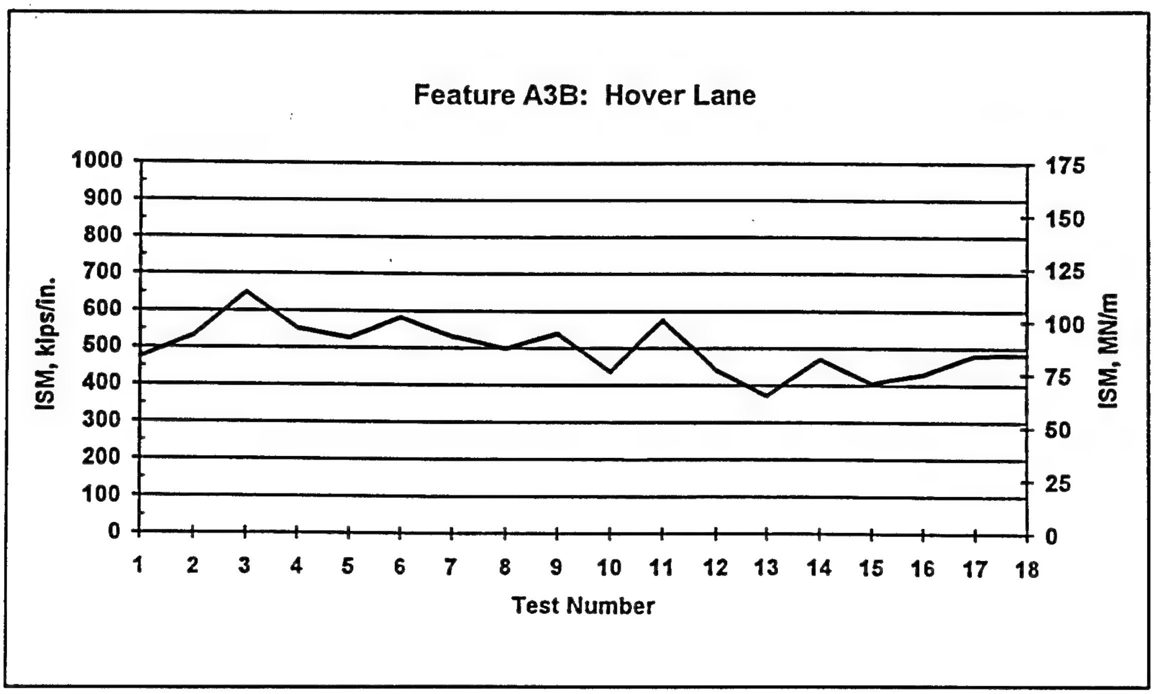


Figure B19. ISM profile for the Hover Lane, feature A3B

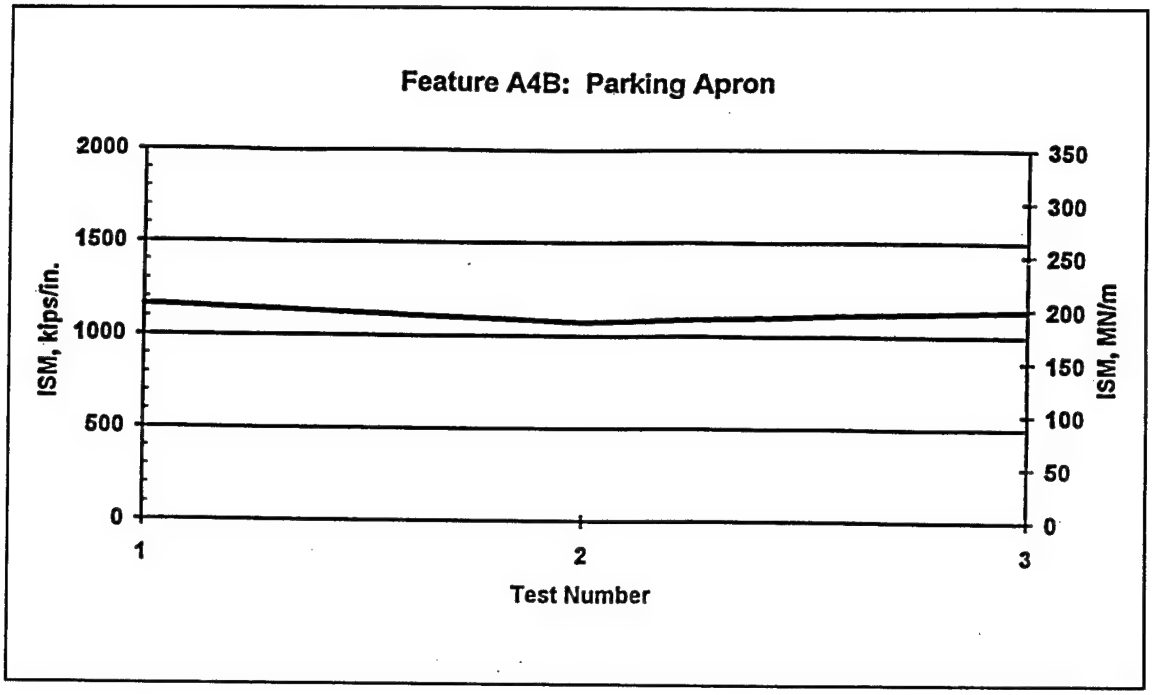


Figure B20. ISM profile for the Parking Apron, feature A4B

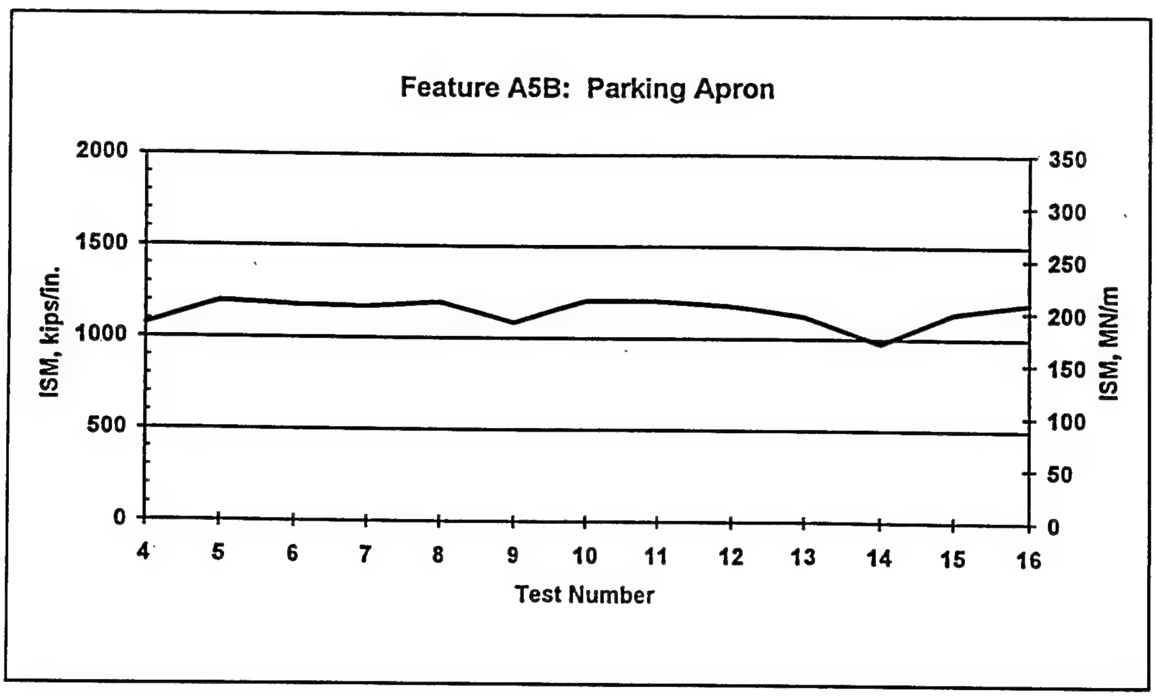


Figure B21. ISM profile for the Parking Apron, feature A5B

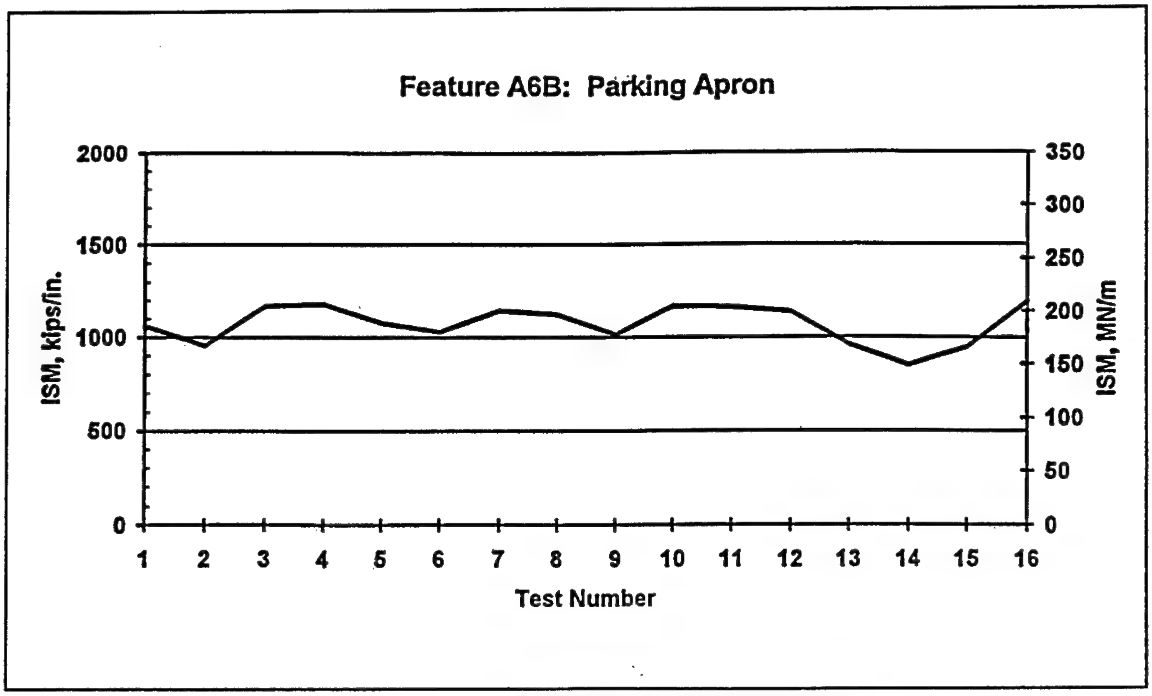


Figure B22. ISM profile for the Parking Apron, feature A6B

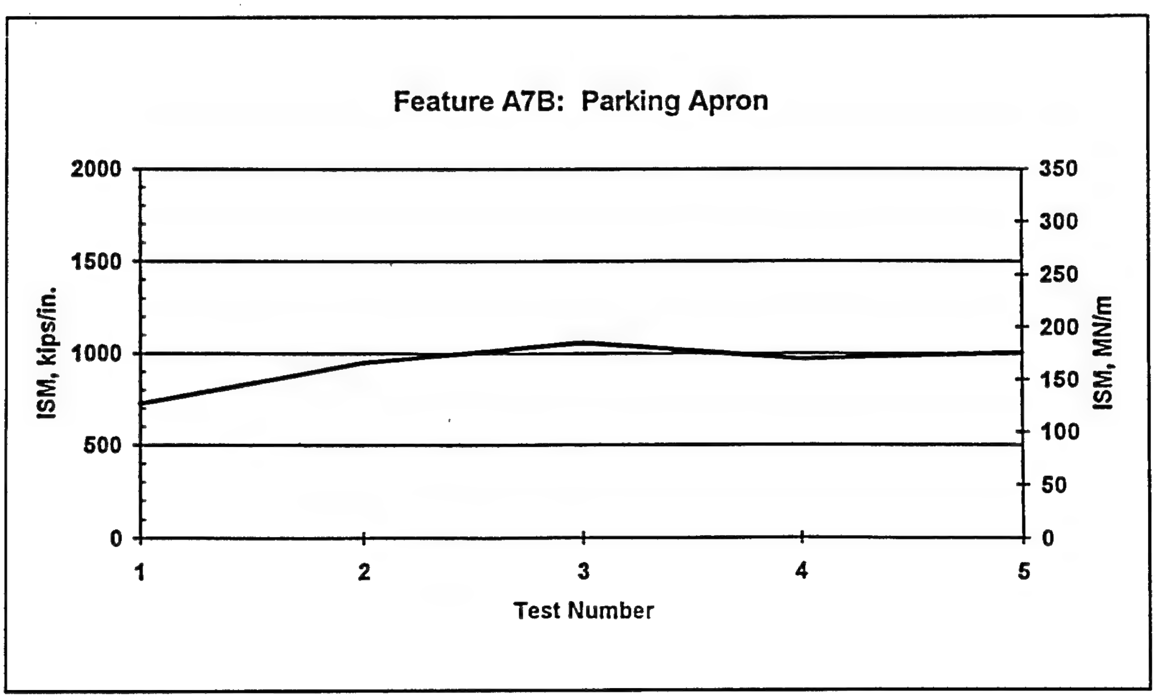


Figure B23. ISM profile for the Parking Apron, feature A7B

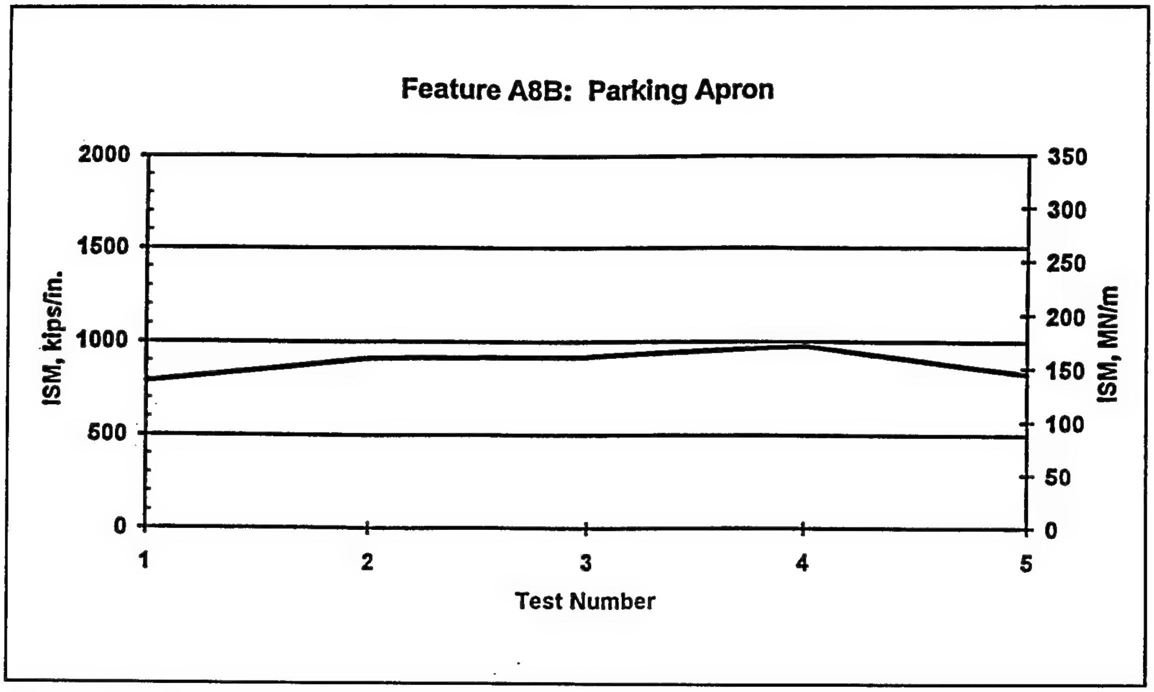


Figure B24. ISM profile for the Parking Apron, feature A8B

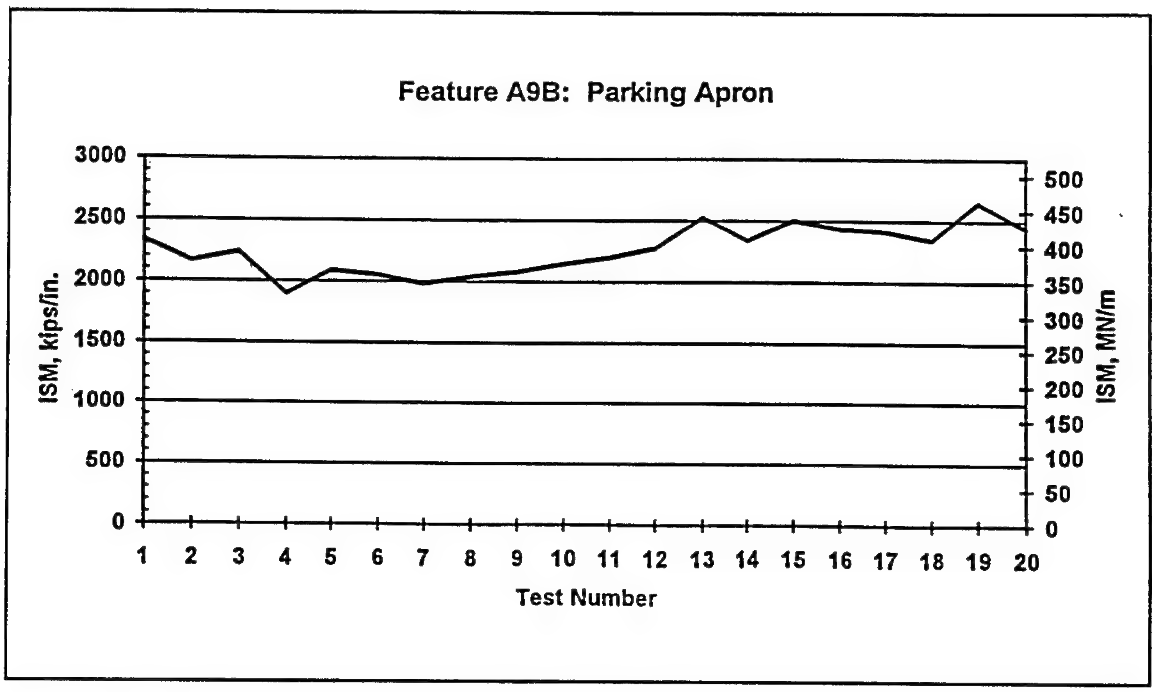


Figure B25. ISM profile for the Parking Apron, feature A9B

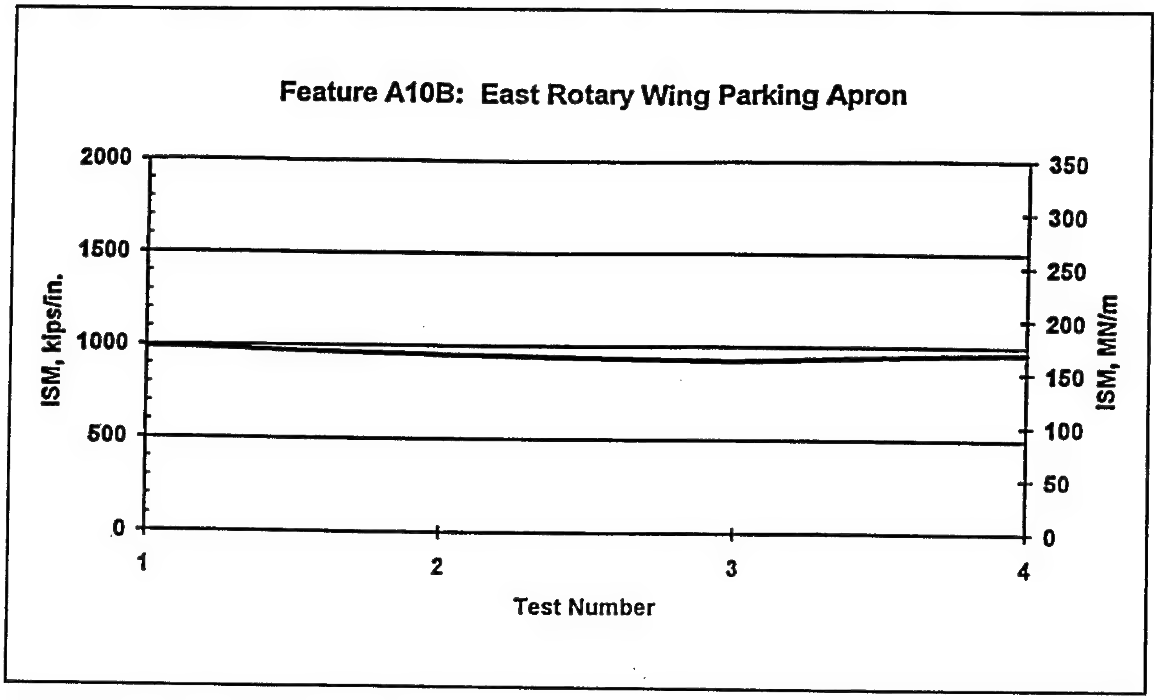


Figure B26. ISM profile for the East Rotary Wing Parking Apron, feature A10B

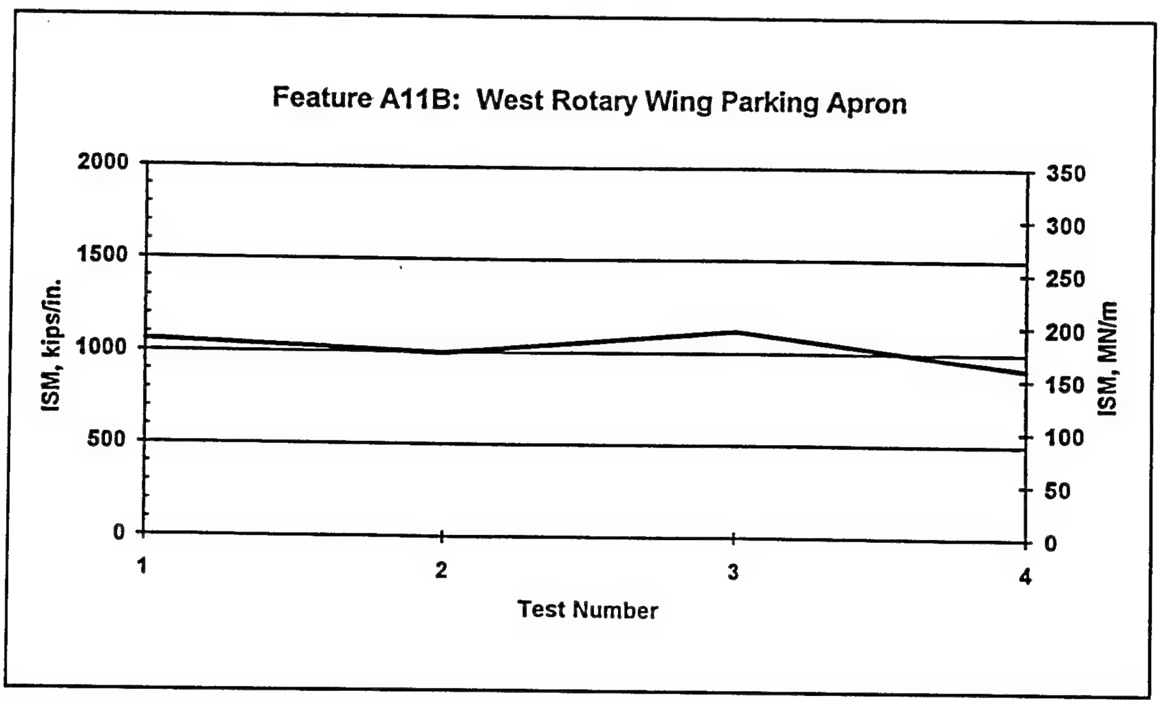


Figure B27. ISM profile for the West Rotary Wing Parking Apron, feature A11B

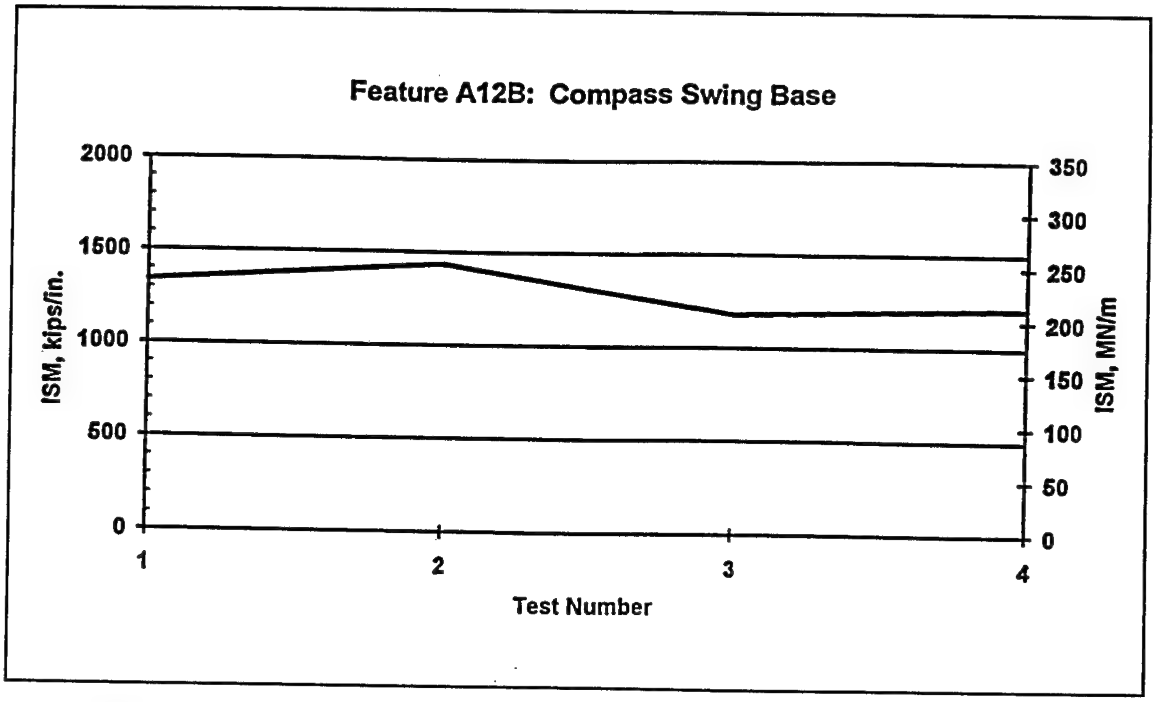


Figure B28. ISM profile for the Compass Swing Base Apron, feature A12B

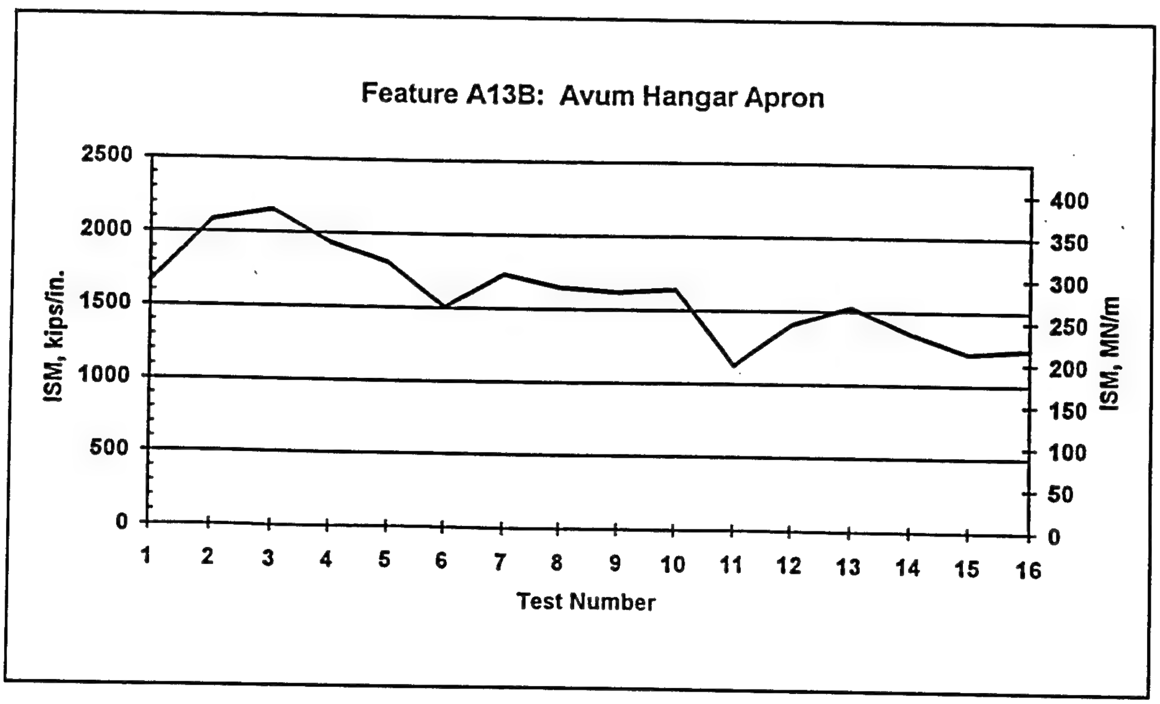


Figure B29. ISM profile for the Avum Hangar Apron, feature A13B

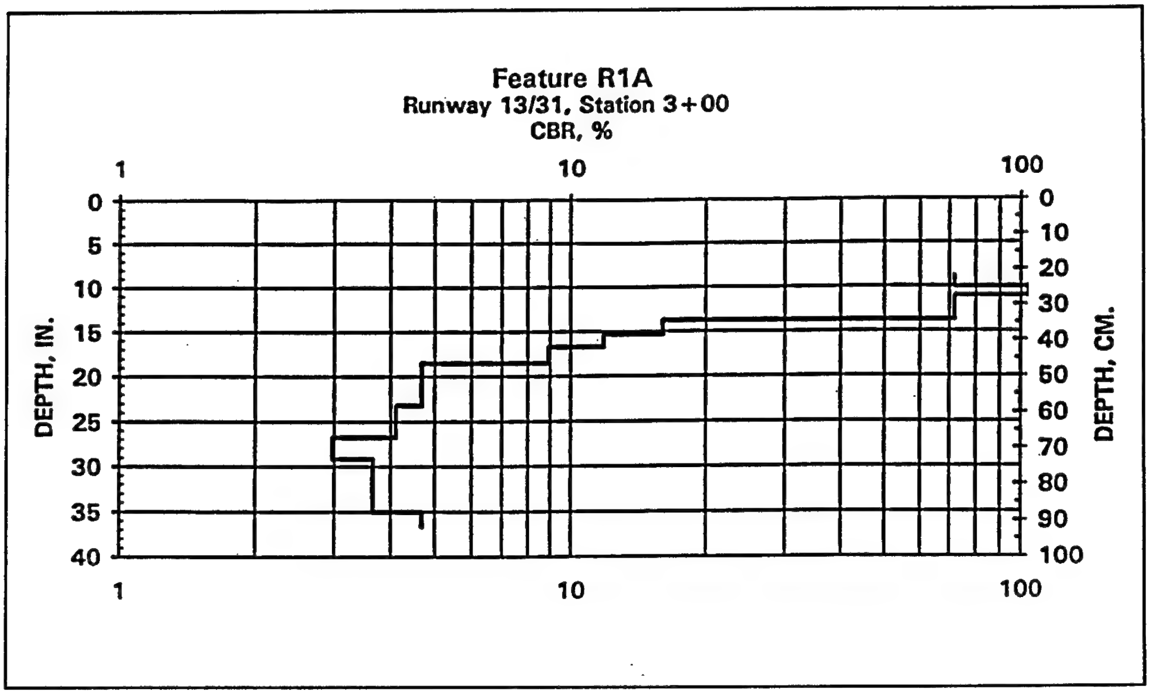


Figure B30. DCP results for Runway 13-31 Overrun, feature R1A

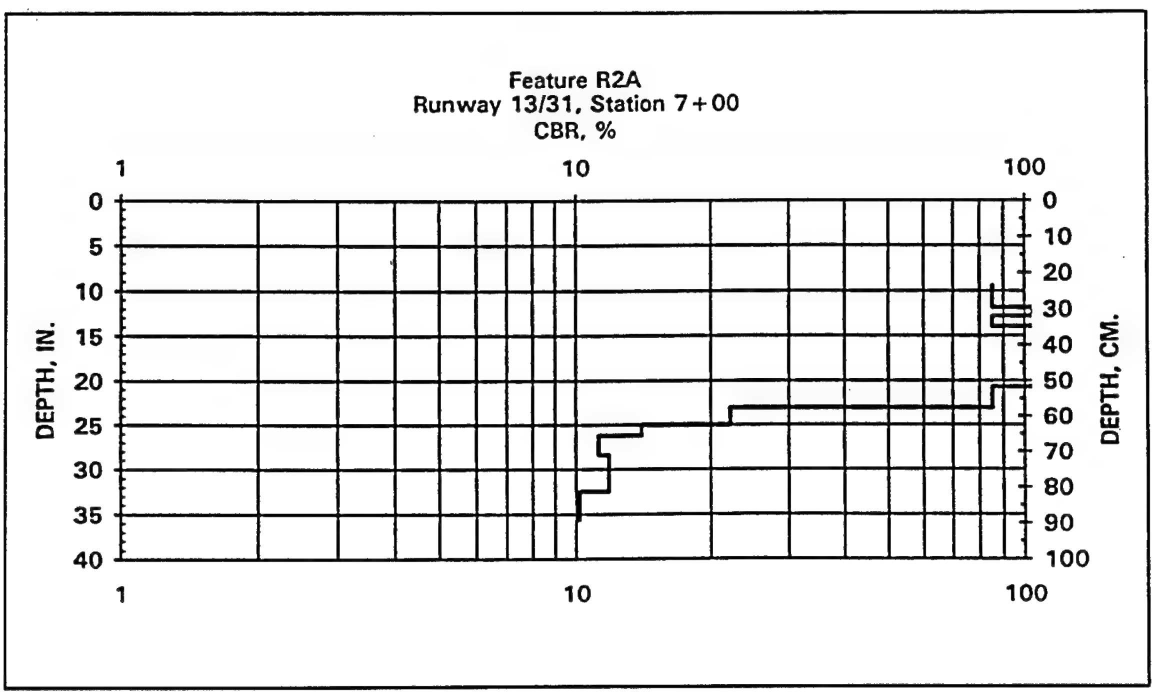


Figure B31. DCP results for Runway 13-31, feature R2A

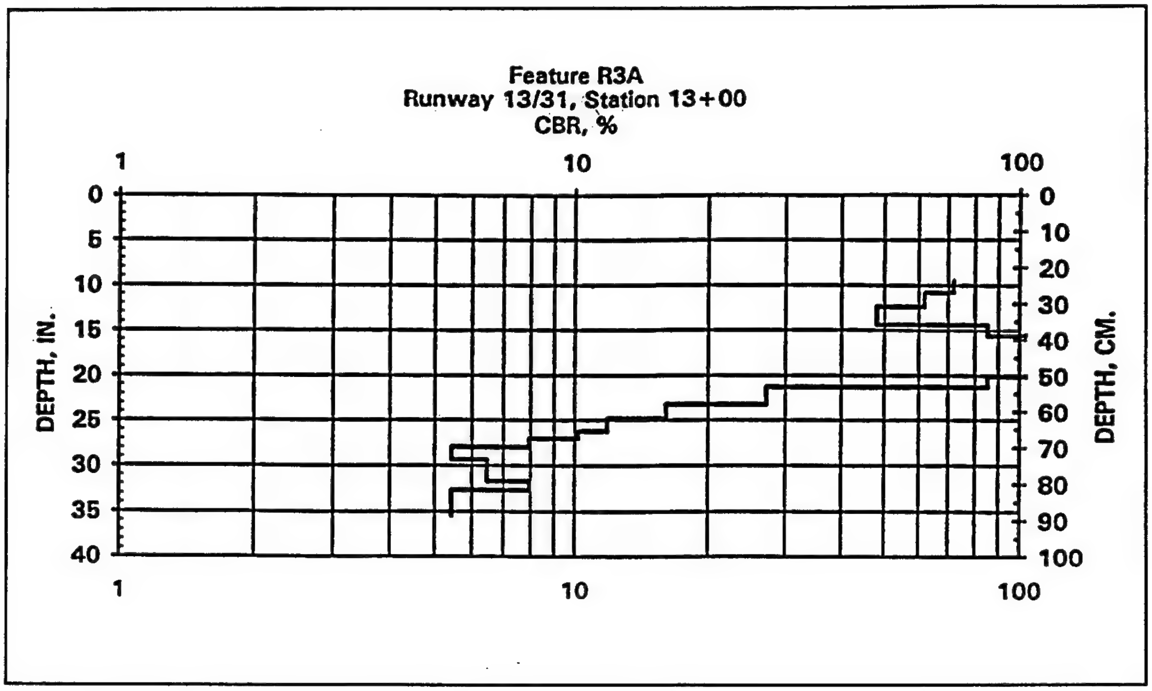


Figure B32. DCP results for Runway 13-31, feature R3A

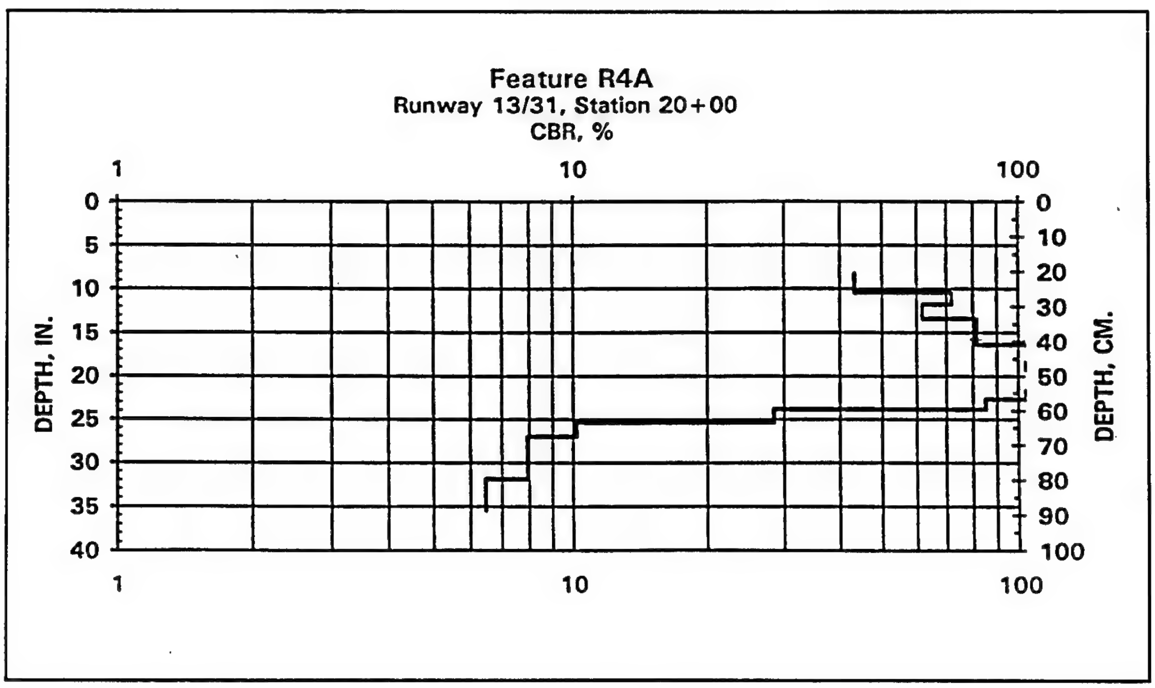


Figure B33. DCP results for Runway 13-31, feature R4A

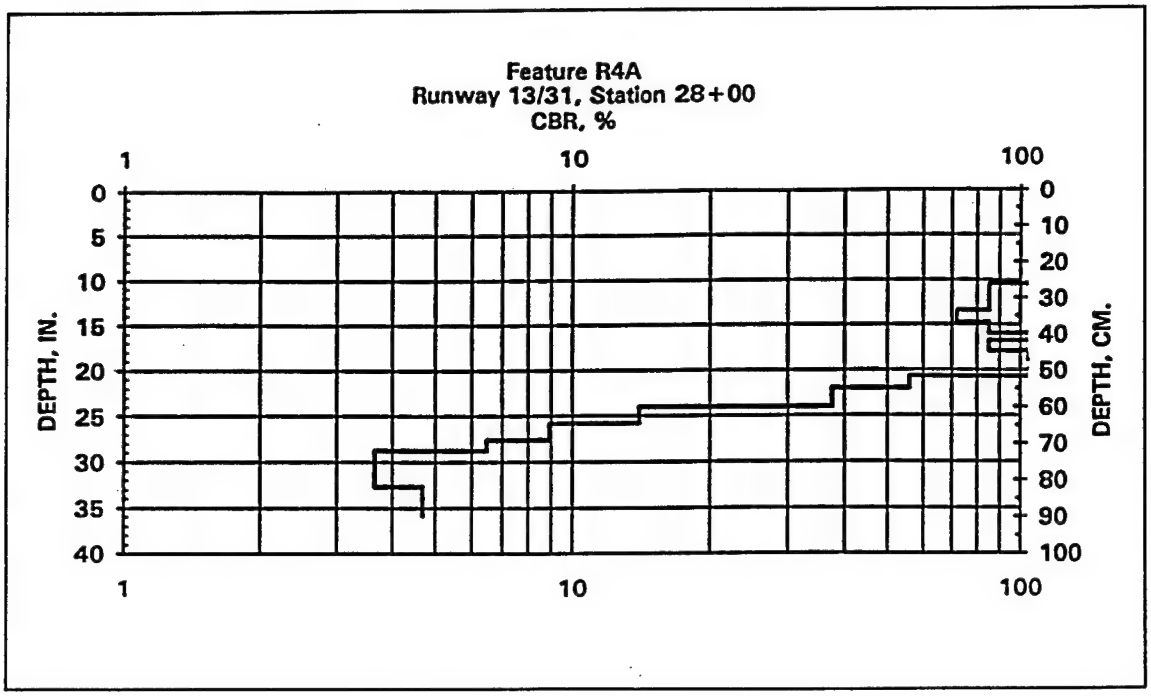


Figure B34. DCP results for Runway 13-31, feature R4A

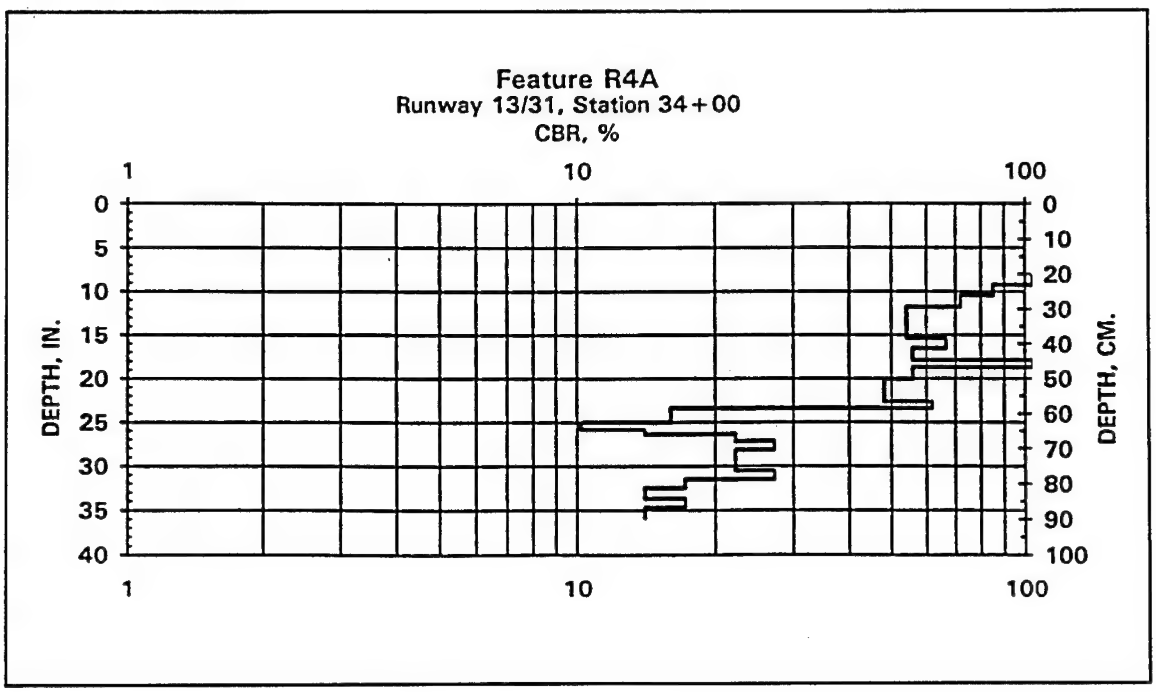


Figure B35. DCP results for Runway 13-31, feature R4A

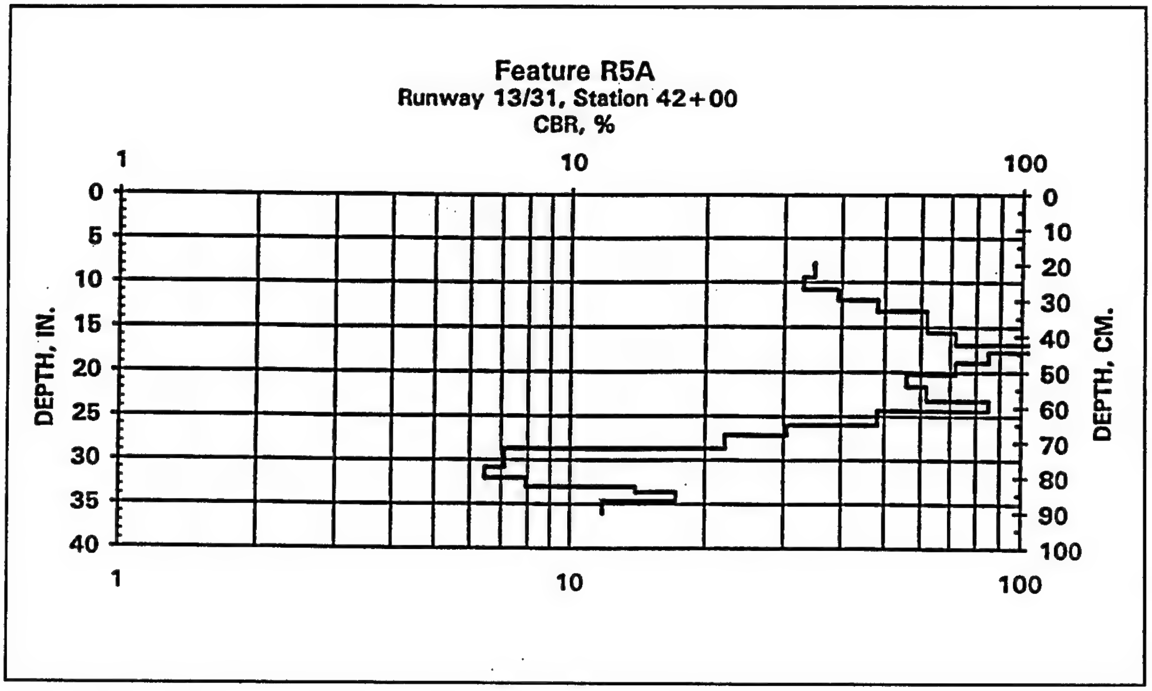


Figure B36. DCP results for Runway 13-31, feature R5A

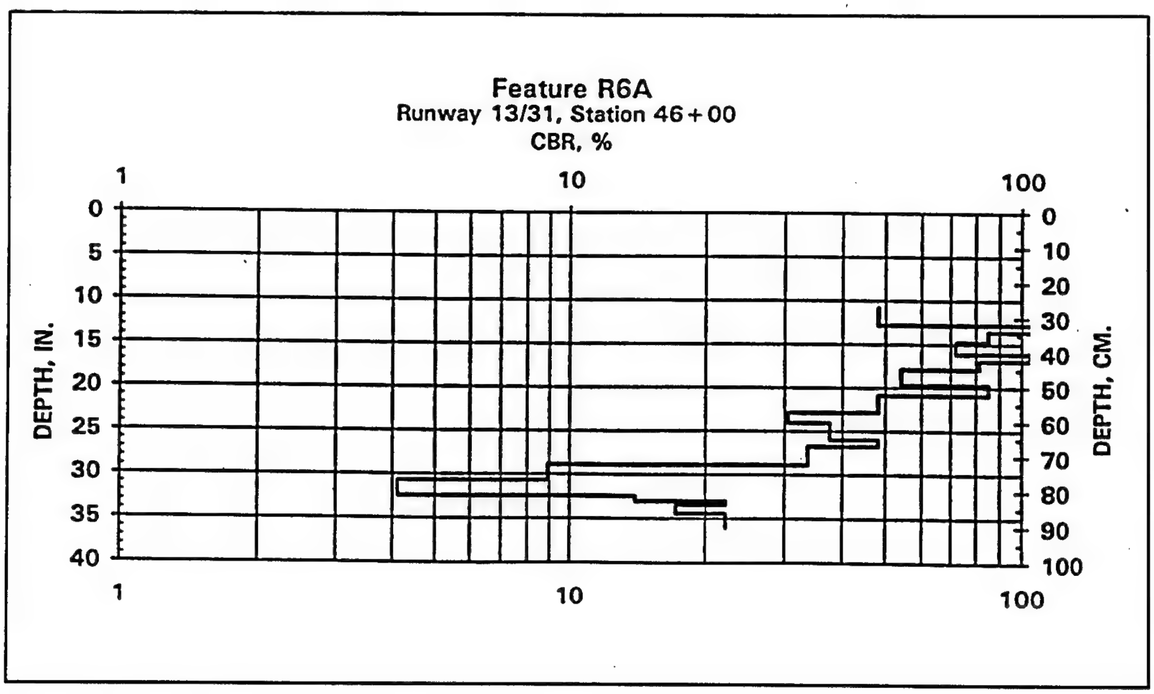


Figure B37. DCP results for Runway 13-31, feature R6A

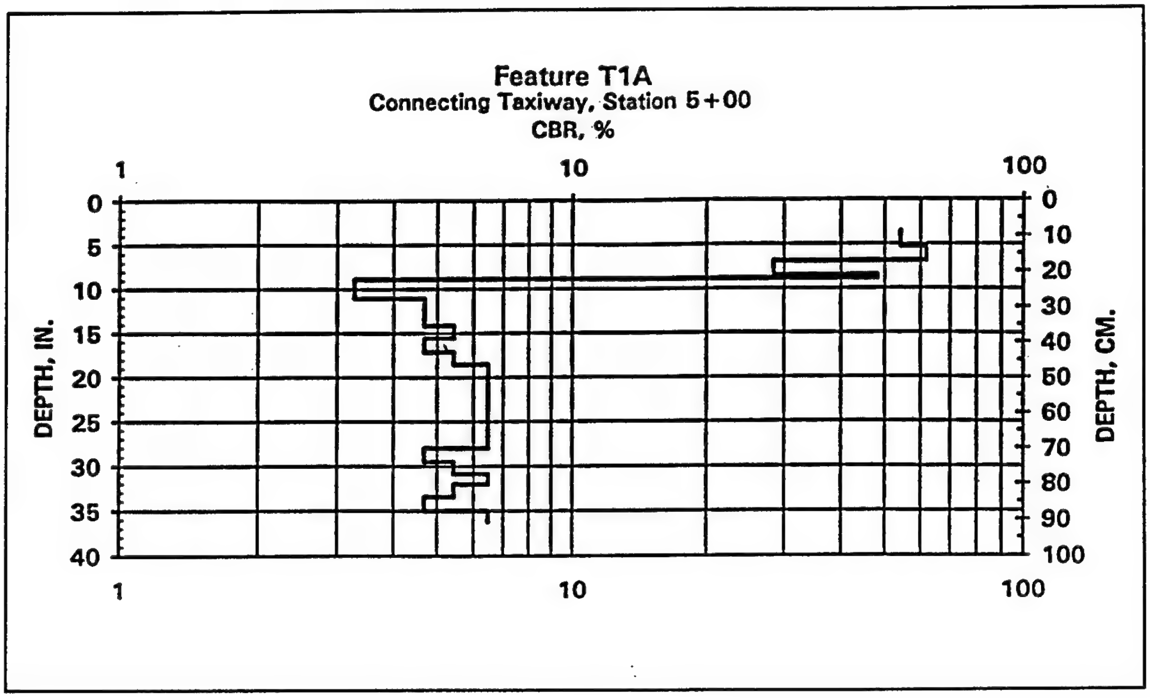


Figure B38. DCP results for Connecting Taxiway, feature T1A

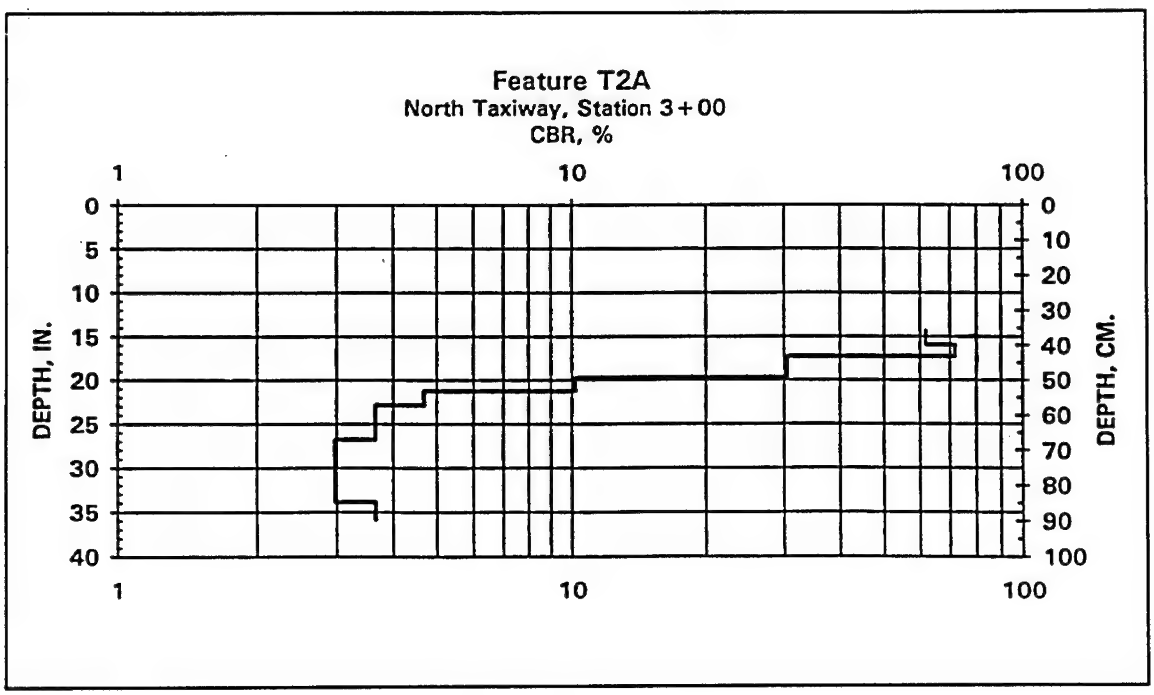


Figure B39. DCP results for North Taxiway, feature T2A

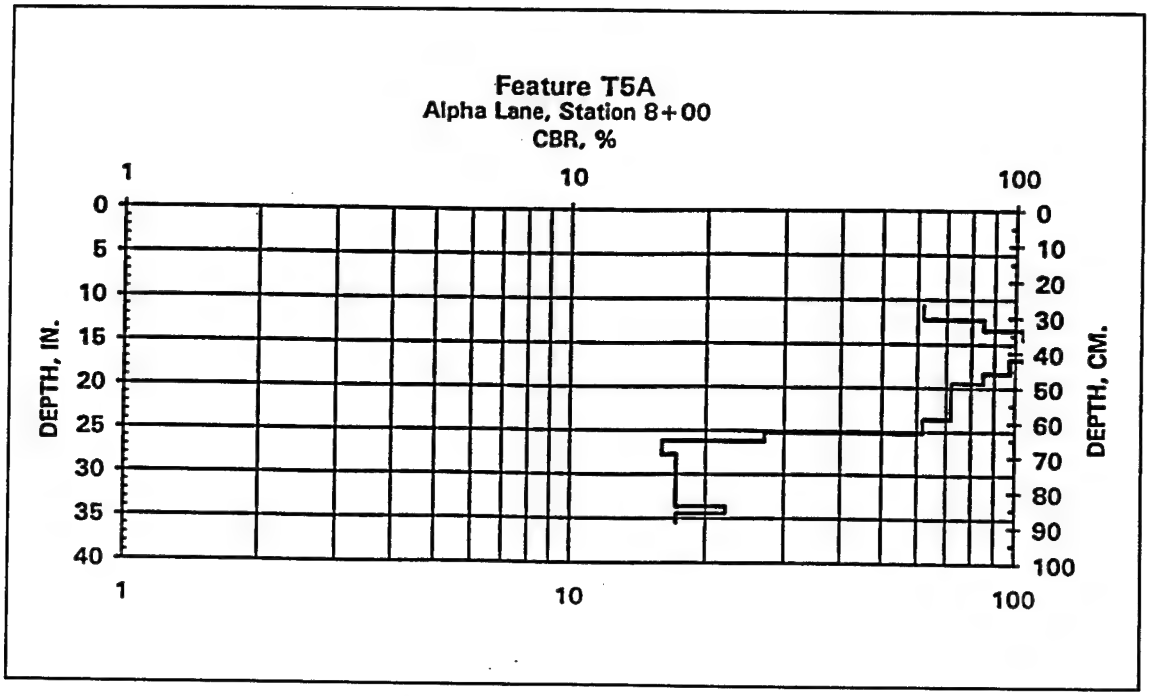


Figure B40. DCP results for Alpha Lane, feature T5A

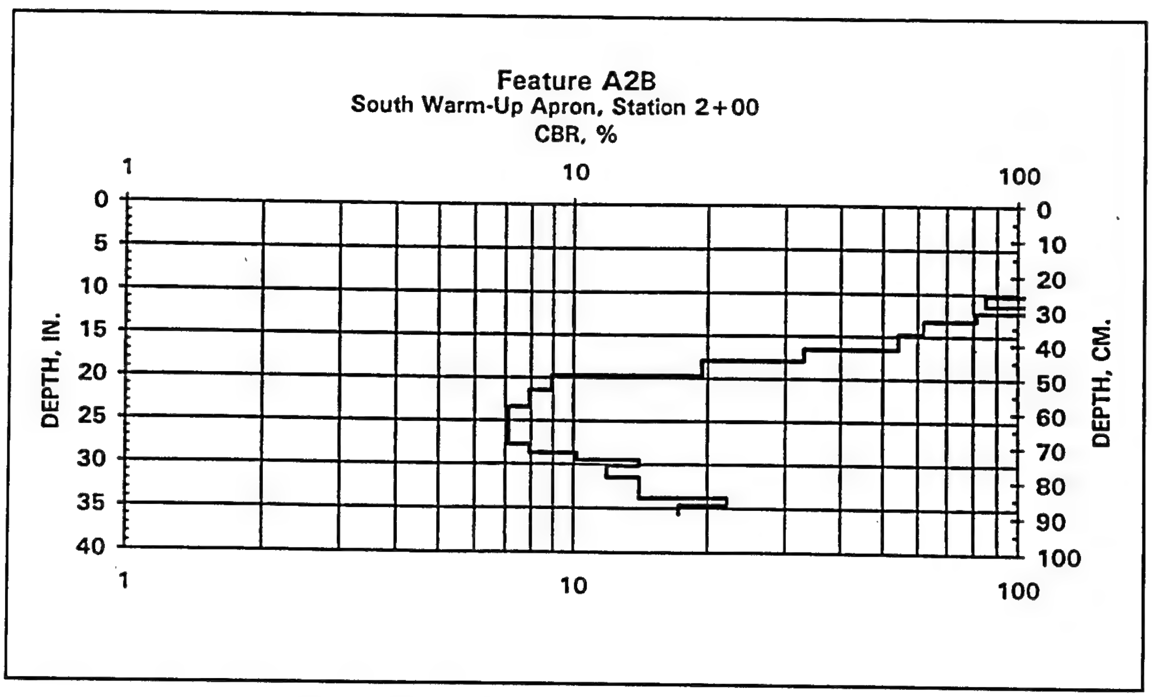


Figure B41. DCP results for South Warm-Up Apron, feature A2B

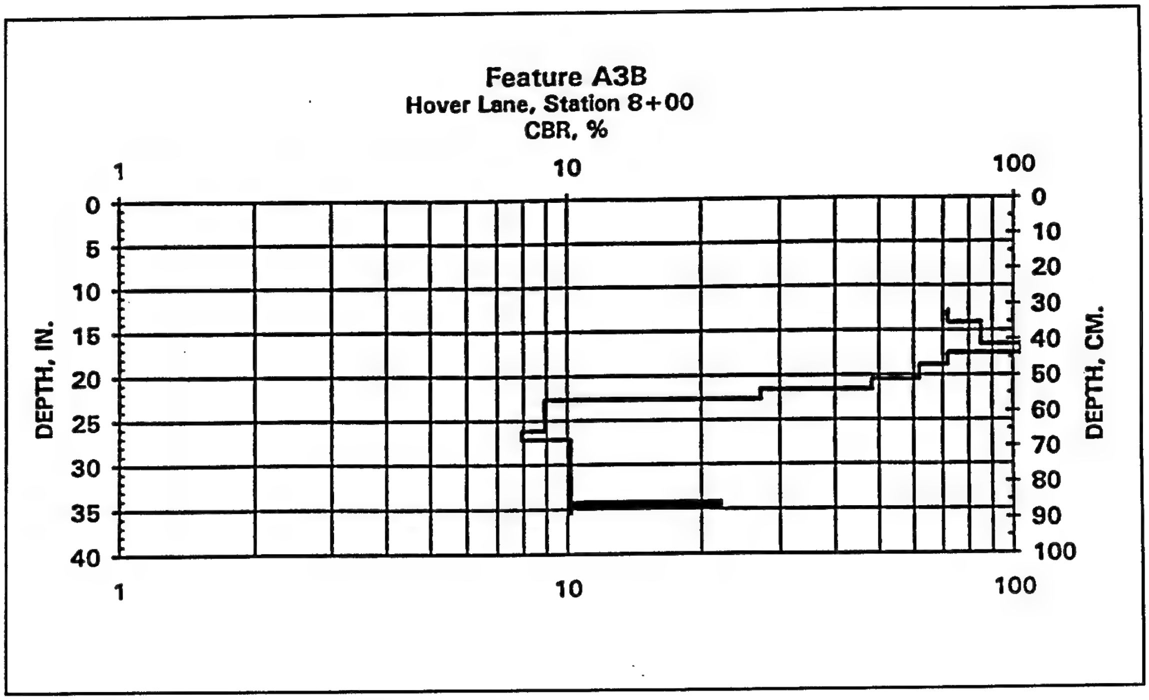


Figure B42. DCP results for Hover Lane, feature A3B

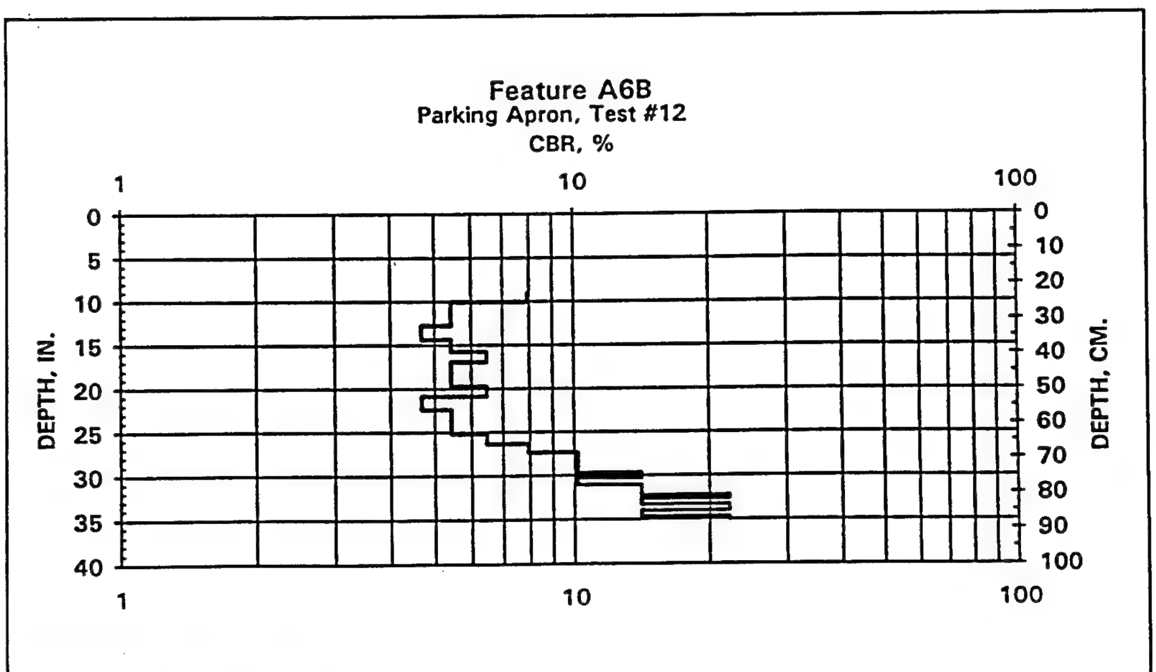


Figure B43. DCP results for Parking Apron, feature A6B

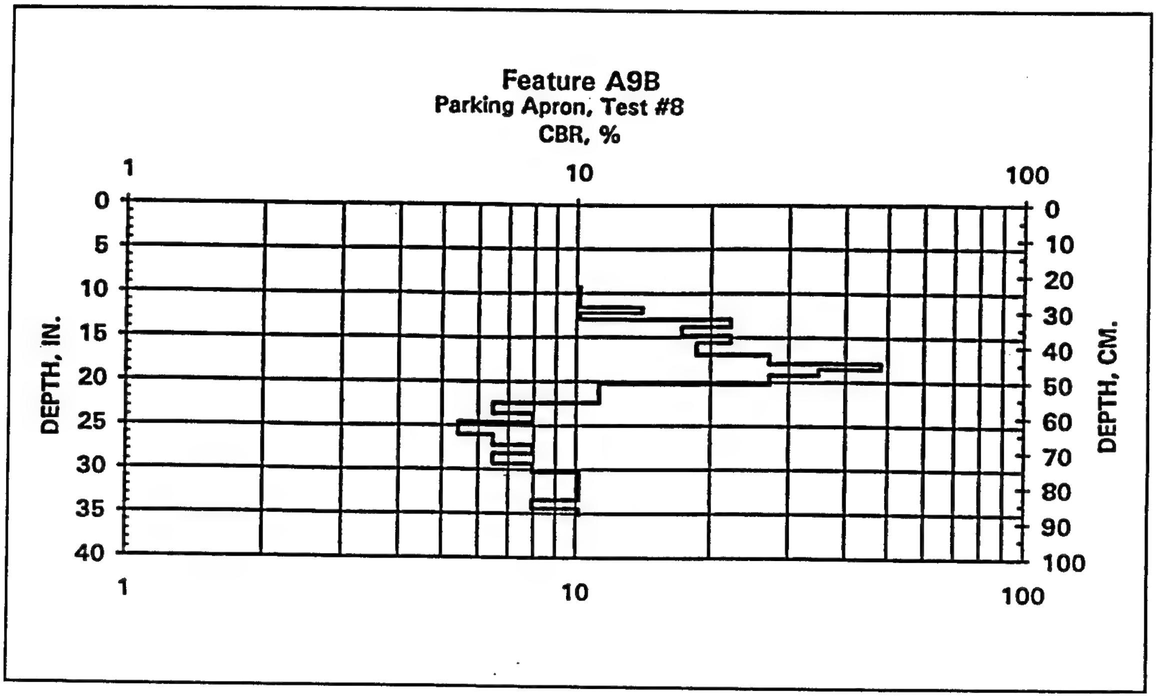


Figure B44. DCP results for Parking Apron, feature A9B

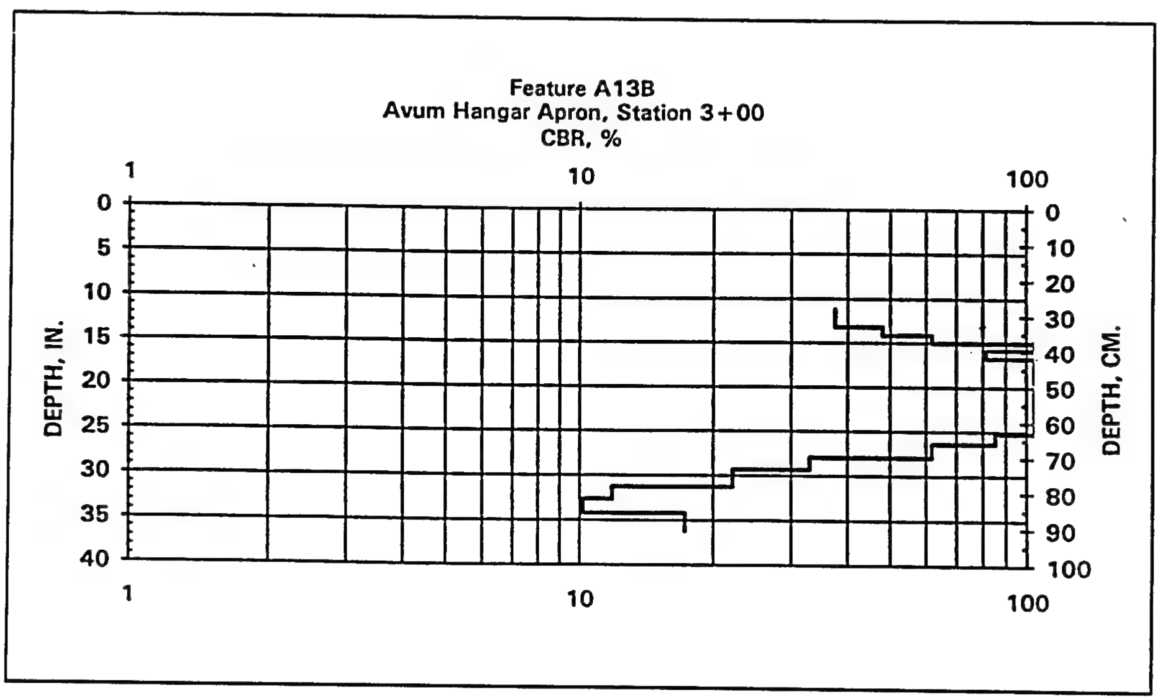


Figure B45. DCP results for Avum Hangar Apron, feature A13B

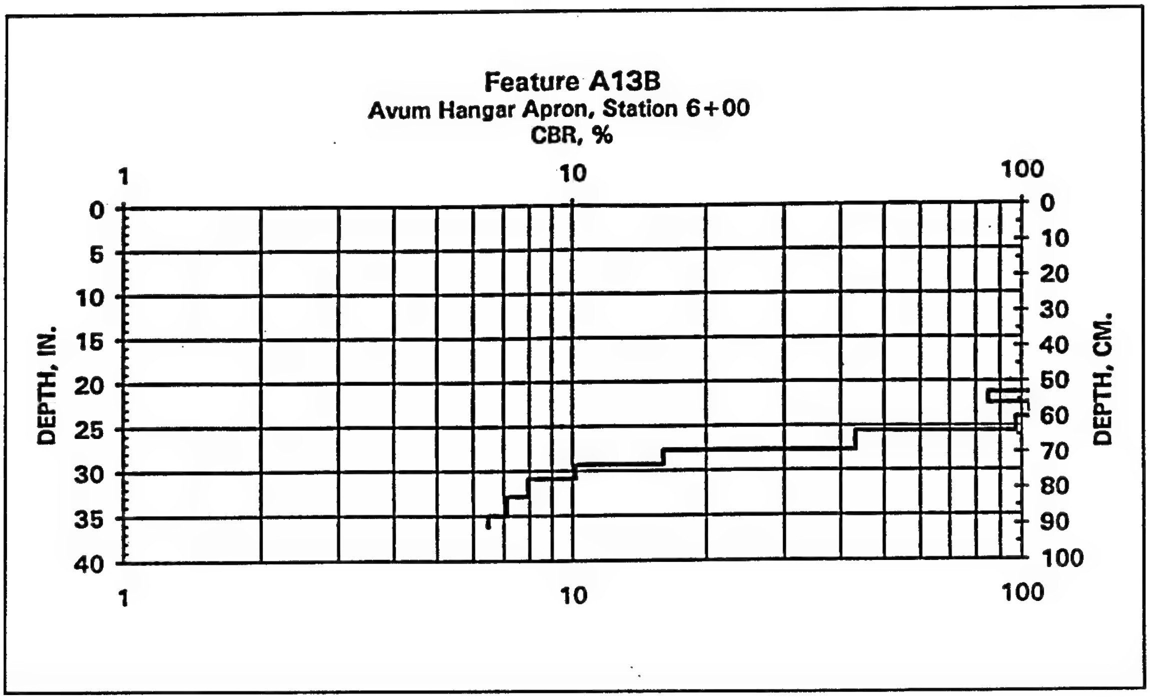


Figure B46. DCP results for Avum Hangar Apron, feature A13B

Table B1
NDT Test Results, Representative Basins

Feature	ISM MN/m (kips/in.)	Force kN (lb)	Deflection, µm (mils)						
			DO	D12	D24	D36	D48	D60	D72
Runway 13-31									
R1A	74 (420)	102 (22,898)	1,501 (59.1)	902 (35.5)	541 (21.3)	356 (14.0)	257 (10.1)	193 (7.6)	152 (6.0)
R2A	92 (523)	122 (27,502)	1,323 (52.1)	904 (35.6)	597 (23.5)	414 (16.3)	297 (11.7)	218 (8.6)	165 (6.5)
R3A	93 (531)	125 (27,998)	1,422 (56.0)	1,024 (40.3)	683 (26.9)	465 (18.3)	323 (12.7)	231 (9.1)	178 (7.0)
R4A	93 (529)	125 (28,130)	1,296 (51.0)	993 (39.1)	630 (24.8)	414 (16.3)	287 (11.3)	211 (8.3)	160 (6.3)
R5A	84 (482)	124 (27,891)	1,468 (57.8)	981 (38.6)	546 (21.6)	330 (13.0)	221 (8.7)	163 (6.4)	124 (4.9)
R6A	98 (558)	125 (28,189)	1,367 (53.8)	881 (34.7)	485 (19.1)	292 (11.5)	201 (7.9)	152 (6.0)	122 (4.8)
Alpha Lane Taxiway									
T5A-1	36 (204)	58 (13,121)	1,783 (70.2)	681 (26.8)	269 (10.6)	163 (6.4)	122 (4.8)	104 (4.1)	84 (3.3)
T5A-2	88 (503)	97 (21,885)	1,140 (44.9)	699 (27.5)	417 (16.4)	282 (11.1)	203 (8.0)	152 (6.0)	122 (4.8)
T5A-3	31 (175)	54 (12,204)	2,540 (100.0)	1,244 (49.0)	422 (16.6)	203 (8.0)	137 (5.4)	114 (4.5)	84 (3.3)
Connecting Taxiway									
T1A	58 (330)	80 (18,011)	1,491 (58.7)	917 (36.1)	549 (21.6)	325 (12.8)	218 (8.6)	163 (6.4)	132 (5.2)
North Taxiway									
T2A	117 (666)	170 (38,315)	1,519 (59.8)	1,146 (45.1)	823 (32.4)	587 (23.1)	424 (16.7)	312 (12.3)	234 (9.2)
Midfield Taxiway									
T3A	368 (2,099)	255 (57,387)	706 (27.8)	640 (25.2)	559 (22.0)	475 (18.7)	399 (15.7)	333 (13.1)	274 (10.8)
Compass Swing Base Taxiway									
T4B	114 (650)	106 (23,811)	1,250 (49.2)	765 (30.1)	472 (18.6)	320 (12.6)	231 (9.1)	175 (6.9)	135 (5.3)

(Continued)

Table B1 (Concluded)									
Feature	ISM MN/m (kips/ in.)	Force kN (lb)	Deflection, μm (mils)						
			DO	D12	D24	D36	D48	D60	D72
North Warm-up Apron									
A1B	93 (532)	167 (37,509)	1,842 (72.5)	1,334 (52.5)	922 (36.3)	643 (25.3)	445 (17.5)	312 (12.3)	226 (8.9)
South Warm-up Apron									
A2B	68 (388)	83 (18,564)	1,151 (45.3)	767 (30.2)	434 (17.1)	251 (9.9)	163 (6.4)	112 (4.4)	81 (3.2)
Hover Lane									
A3B	87 (499)	128 (28,825)	1,522 (59.9)	1,059 (41.7)	625 (24.6)	401 (15.8)	264 (10.4)	185 (7.3)	140 (5.5)
Parking Apron									
A4B	197 (1,124)	236 (53,017)	1,184 (46.6)	1,080 (42.5)	935 (36.8)	775 (30.5)	615 (24.2)	462 (18.2)	328 (12.9)
A5B	201 (1,147)	233 (52,290)	1,128 (44.4)	1,057 (41.6)	899 (35.4)	734 (28.9)	569 (22.4)	417 (16.4)	295 (11.6)
A6B	188 (1,074)	233 (52,306)	1,229 (48.4)	1,090 (42.9)	922 (36.3)	754 (29.7)	589 (23.2)	434 (17.1)	295 (11.6)
A7B	165 (941)	222 (49,994)	1,336 (52.6)	1,237 (48.7)	1,014 (39.9)	790 (31.1)	589 (23.2)	450 (17.7)	340 (13.4)
A8B	155 (885)	222 (49,831)	1,377 (54.2)	1,247 (49.1)	1,042 (41.0)	828 (32.6)	630 (24.8)	450 (17.7)	323 (12.7)
A9B	395 (2,257)	233 (52,275)	584 (23.0)	531 (20.9)	462 (18.2)	394 (15.5)	323 (12.7)	279 (11.0)	229 (9.0)
East Rotary Wing Parking Apron									
A10B	168 (959)	234 (52,676)	1,382 (54.4)	1,268 (49.9)	1,085 (42.7)	897 (35.3)	711 (28.0)	549 (21.6)	422 (16.6)
West Rotary Wing Parking Apron									
A11B	179 (1,022)	236 (53,006)	1,351 (53.2)	1,283 (50.5)	1,095 (43.1)	897 (35.3)	709 (27.9)	561 (22.1)	455 (17.9)
Compass Swing Base									
A12B	226 (1,293)	235 (52,870)	1,001 (39.4)	925 (36.4)	805 (31.7)	688 (27.1)	582 (22.9)	475 (18.7)	373 (14.7)
Avum Hangar Apron									
A13B	281 (1,605)	237 (53,347)	887 (34.9)	765 (30.1)	622 (24.5)	495 (19.5)	389 (15.3)	297 (11.7)	221 (8.7)

Table B2
Summary of Modulus Values

Feature	AC Modulus MPa (psi)[1]	Base Modulus MPa (psi)[1]	Subgrade Modulus MPa (psi)[1]
AC Pavements			
R1A[2]	–	–	–
R2A	1,219 (176,734)	146 (21,207)	67 (9,769)
R3A	1,398 (202,740)	125 (18,150)	66 (9,537)
R4A	1,819 (263,807)	111 (16,117)	74 (10,767)
R5A	1,194 (173,141)	95 (13,819)	94 (13,658)
R6A	1,152 (167,013)	115 (16,733)	102 (14,831)
T1A[2]	–	–	–
T2A[4]	1,379 (200,000)	959 (139,017)	68 (9,819)
T4B[4]	1,379 (200,000)	526 (76,274)	77 (11,197)
T5A-1[2]	–	–	–
T5A-2[4]	1,379 (200,000)	432 (62,717)	80 (11,570)
T5A-3[2]	–	–	–
A1B	20,461 (2,967,476)	240 (34,785)	64 (9,323)
A2B[2]	–	–	–
A3B	16,374 (2,374,822)	155 (22,443)	80 (11,614)
PCC Pavements[3]			
T3A	50,093 (7,265,264)	103 (14,868)	103 (14,868)
A4B	35,866 (5,201,780)	73 (10,568)	73 (10,568)
A5B	33,088 (4,798,820)	79 (11,421)	79 (11,421)
A6B	29,212 (4,236,689)	78 (11,242)	78 (11,242)
A7B	23,679 (3,434,300)	70 (10,170)	70 (10,170)
A8B	22,470 (3,258,874)	68 (9,912)	68 (9,912)
A9B	56,039 (8,127,556)	112 (16,215)	112 (16,215)
A10B	32,792 (4,755,905)	60 (8,713)	60 (8,713)
A11B	36,068 (5,231,059)	58 (8,439)	58 (8,439)
A12B	64,060 (9,290,756)	68 (9,796)	68 (9,796)
A13B	40,769 (5,912,792)	115 (16,750)	115 (16,750)

1 Backcalculated modulus values using WESDEF.
2 ISM less than 400, use LOW to compute subgrade CBR (percent).
3 Base and subgrade combined to backcalculate modulus values.
4 AC modulus assigned to backcalculate base and subgrade modulus values.

Appendix C
Pavement Condition Survey and Results

Pavement Condition Survey

A pavement condition survey is a visual inspection of the airfield pavements to determine their present surface condition. The condition survey consists of inspecting the pavement surfaces for the various types of distresses, determining the severity of each distress, and measuring the quantity of each distress. The condition survey provides estimated quantities of each distress type and severity with the pavement condition index (PCI) for each feature. The PCI is a numerical indicator based on a scale from 0 to 100 and is determined by measuring pavement surface distress that reflects the surface condition of the pavement. Pavement condition ratings (from excellent to failed) are assigned to different levels of PCI values. These ratings and their respective PCI value definitions are shown in Figure C1. The distress types, distress severities, methods of survey, and PCI calculation are described in ASTM 5340-93.

Condition survey procedure

The PCI and estimated distress quantities are determined for each feature. The information is based on inspection of a selected number of sample units. Sample units are subdivisions of a feature used exclusively to facilitate the inspection process and reduce the effort needed to determine distress quantities and the PCI. Each feature was divided into sample units. The sample units for AC pavement features were approximately 465 sq m (5,000 sq ft), and the sample units for the PCC pavement features contained approximately 20 slabs. A statistical sampling technique was used to determine the number of sample units to be inspected to provide a 95 percent confidence level. Sample units were chosen along the center line of the runway and taxiways and were chosen randomly on aprons. The stationing and direction of survey are shown in Figure B1. The locations of the sample units on the PCC pavements are shown in Figure C2. After the sample units were inspected, the mean PCI of all sample units within a feature was calculated and the feature was rated as to its condition: excellent, very good, good, fair, poor, very poor, and failed.

Analysis of PCI Data

The distress information collected during the survey was used with the MicroPAVER program to estimate the quantities of distress types for each feature. This information is presented along with the PCI, general rating, and distress mechanism (load, climate, or other) in Appendix E. The major distress types observed on the PCC pavements were corner breaks, linear cracking, patching, shattered slabs, poor quality joint sealant, joint spalls, and corner spalls. The major distress types found on the AC pavements were alligator cracking, block cracking, longitudinal and transverse cracking, weathering, and rutting. Photos C1 through C10 show various types of distresses observed during the survey.

AR 420-72 (Headquarters, Department of the Army, 1991a) requires that all airfield pavements be maintained at or above the following PCI ranges:

All runways and primary taxiways, 65 to 75.
All aprons and secondary taxiways, 40 to 55.

Recommendations for maintenance or repair to improve existing PCI values are presented in Table 3-2. These were developed based on a decision process by which the pavement engineer can select from multiple alternatives after giving consideration to both the surface condition and structural capacity of the pavement feature. In this process, both the PCI condition rating and the NDT structural rating are required. The results of these two ratings are used with the decision process flowchart to determine the most appropriate work classification category (maintenance, repair, or construction). The recommendations shown in Table 3-2 were selected from maintenance, repair, and construction alternatives suggested for various distresses. The alternatives are shown in Tables 3-3 and 3-4. Often, the performance of a specific alternative depends upon the geographical location and expertise of local contractors. Therefore, it is suggested that the local DPW personnel review all recommendations. Local costs for the approved alternatives can then be used with the Micro PAVER program to obtain a reasonable cost estimate. All structural improvements or construction should be in accordance with TM 5-825-1/AFMAN 32-8008, Vol. 1 (Headquarters, Departments of the Army and the Air Force 1994) which requires PCC at runway ends and for the primary taxiway and parking apron systems.

Condition survey results

A summary of the pavement condition survey results is shown in tabular form in Table C1. Table C1 lists the sample unit number, location, PCI, and rating of each sample unit inspected. The mean PCI for each feature was calculated to determine the general condition or rating of the feature as shown in Figure C3. A comparison of the 1993 and 1995 PCI results is summarized in Table C2.

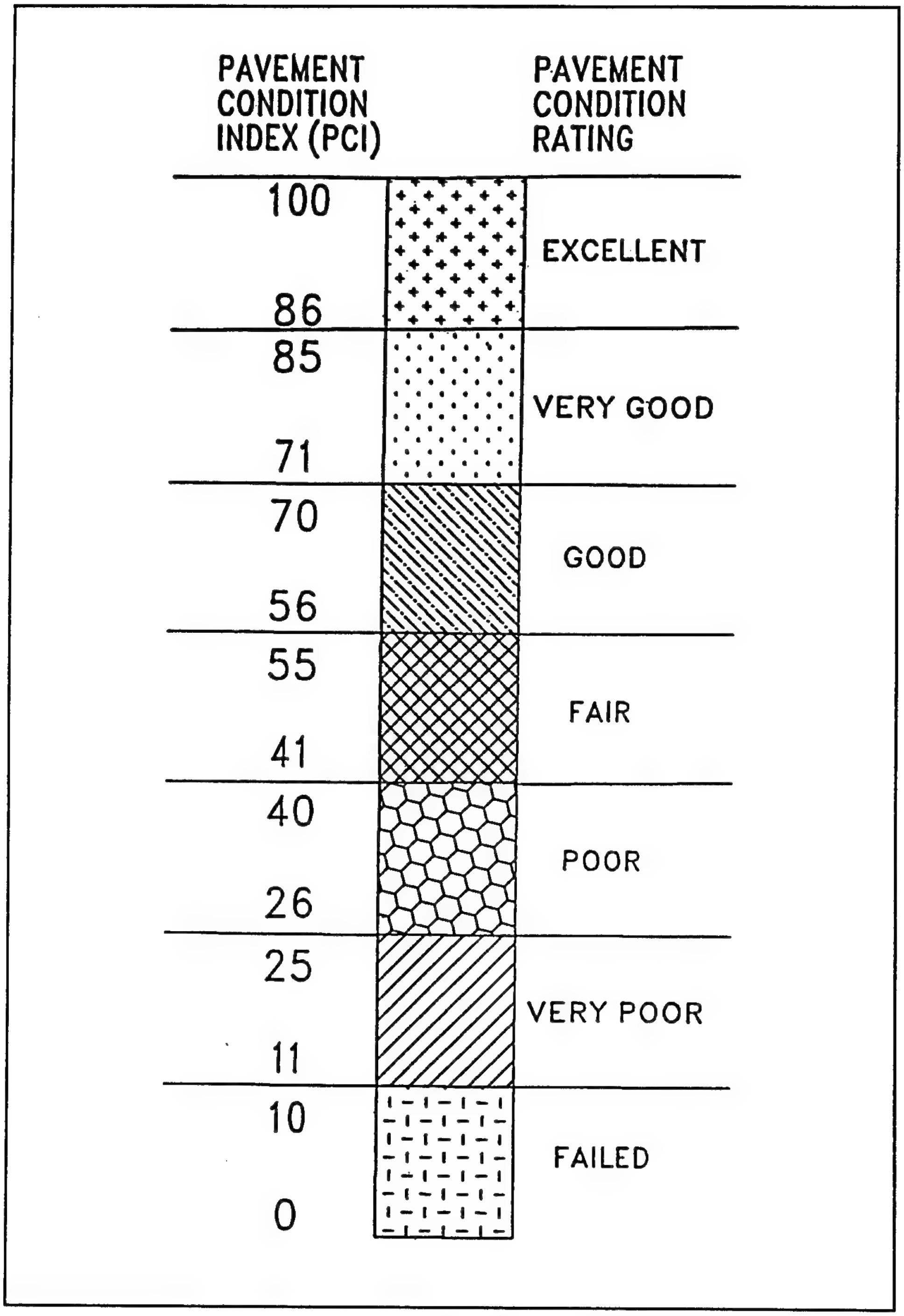


Figure C1. Scale for pavement condition rating

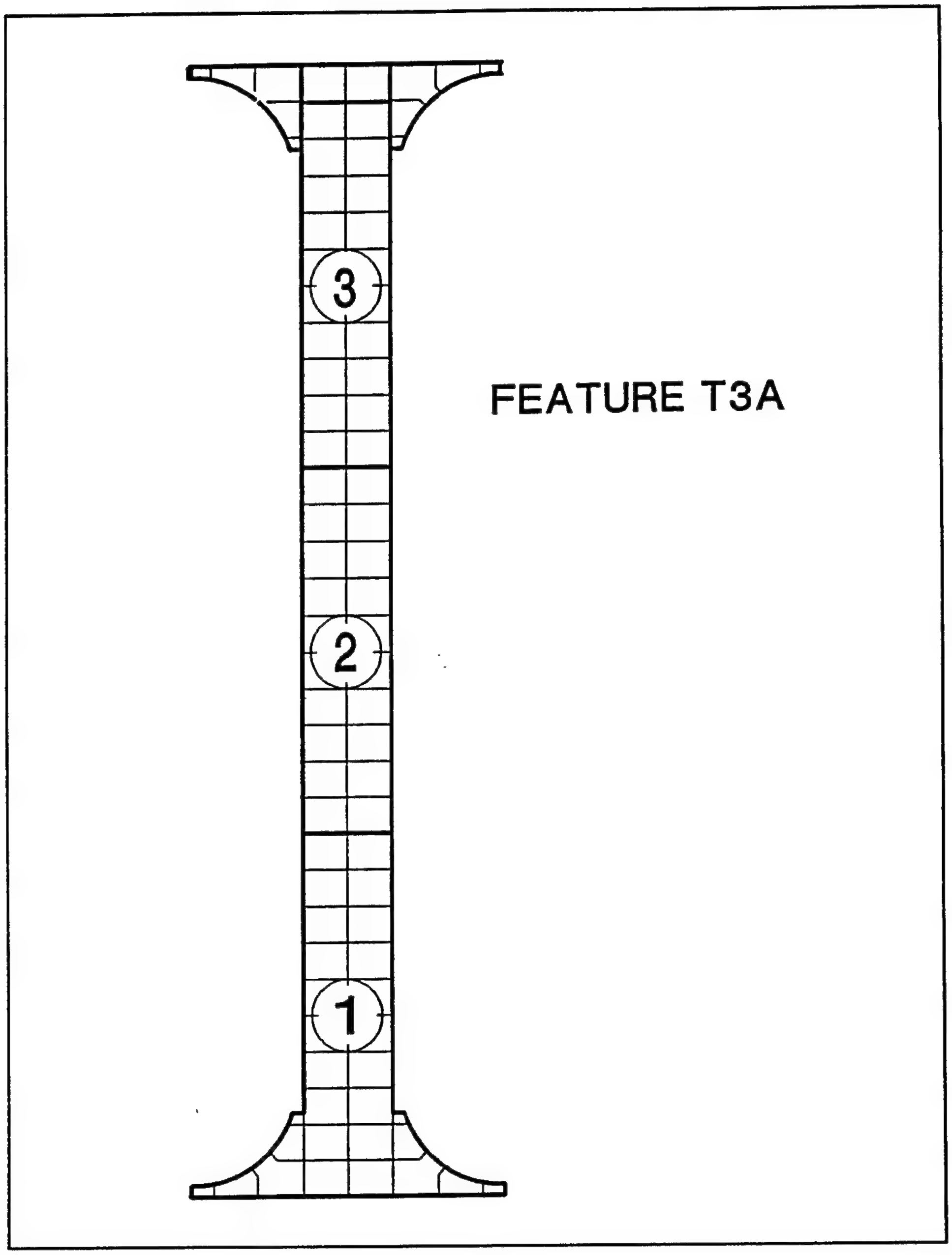


Figure 2. Sample unit layout (Sheet 1 of 9)

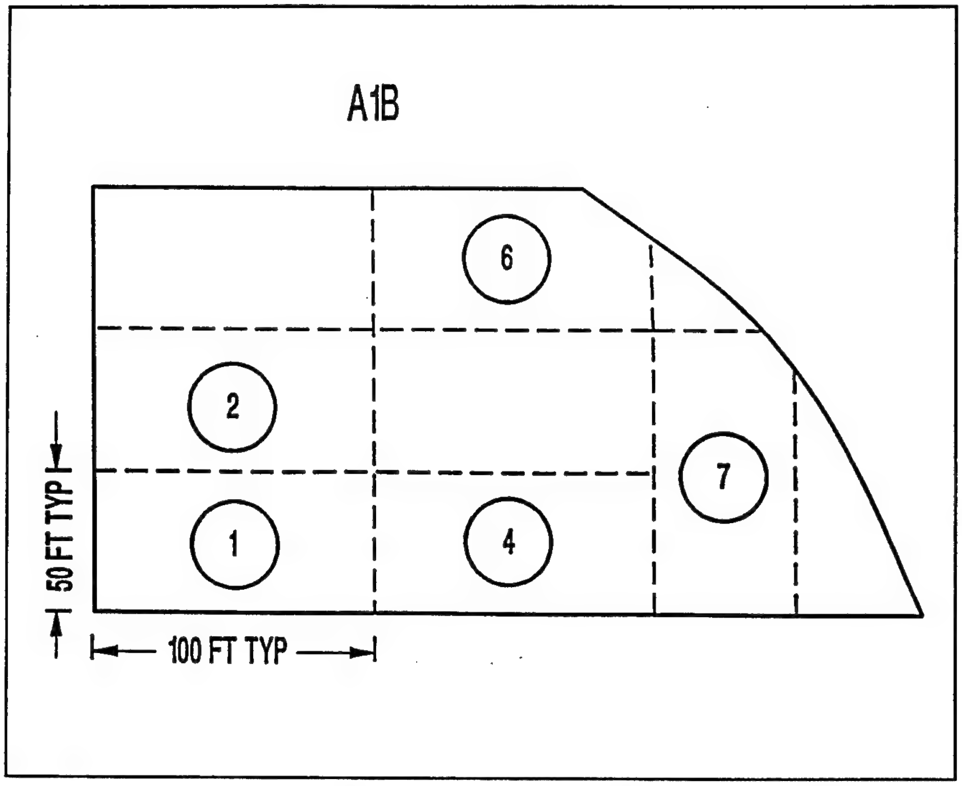


Figure 2. (Sheet 2 of 9)

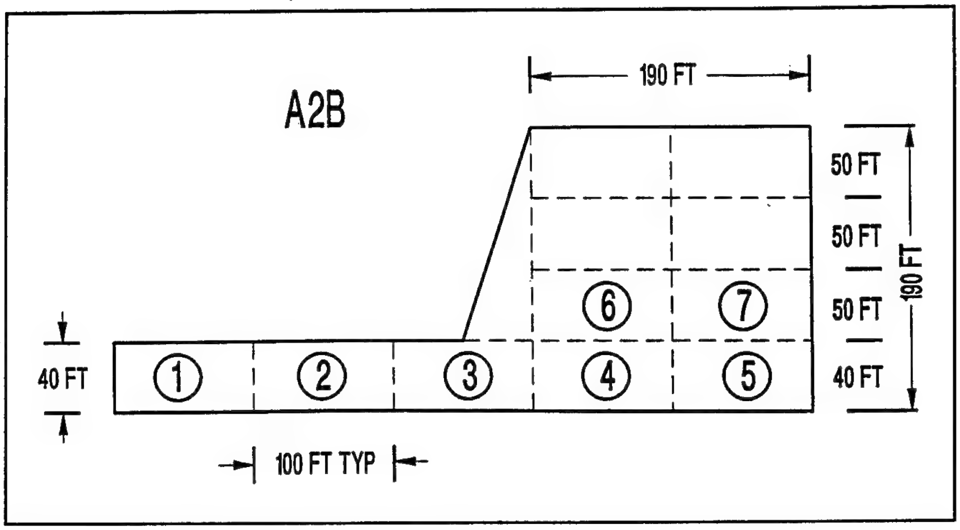


Figure 2. (Sheet 3 of 9)

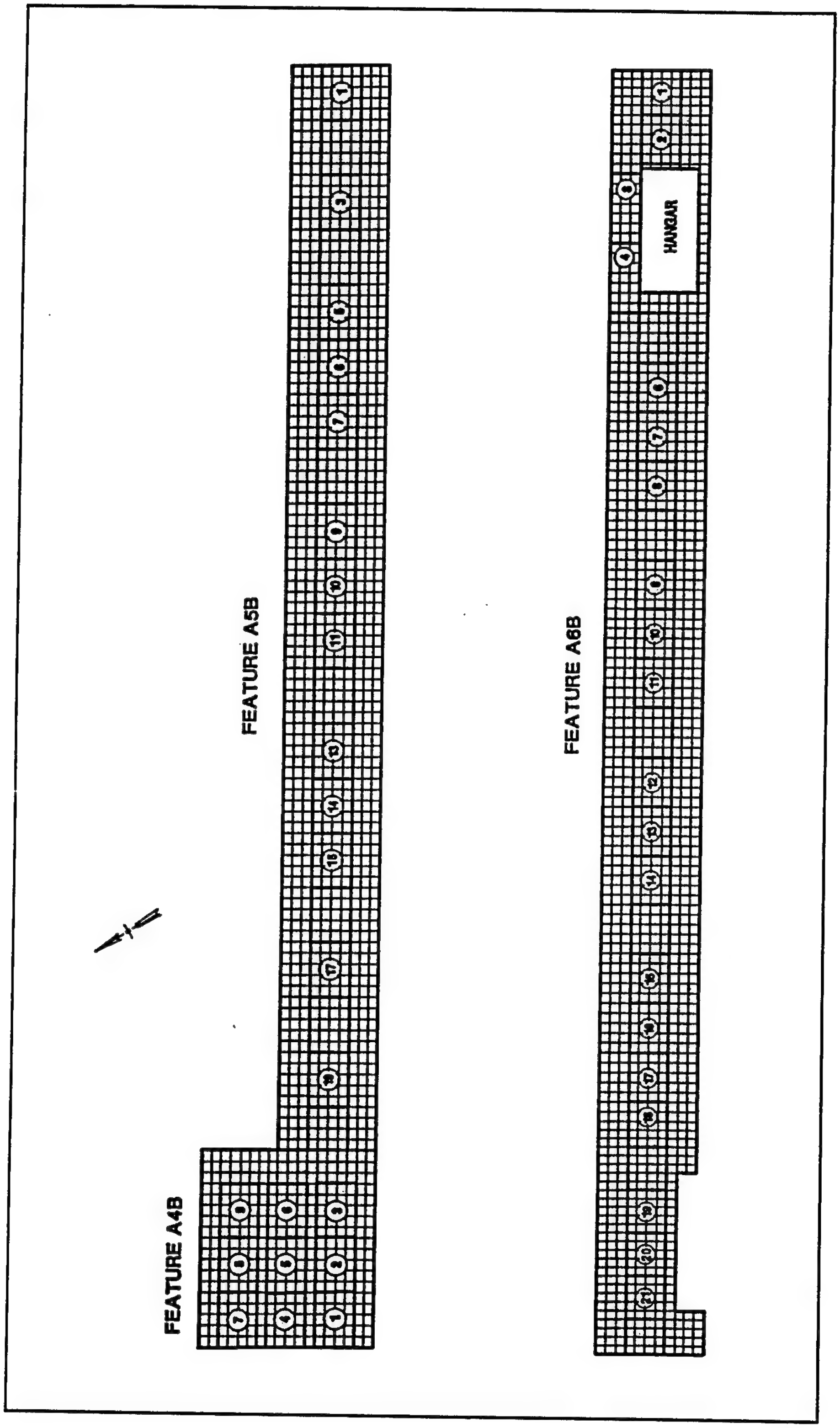


Figure 2. (Sheet 4 of 9)

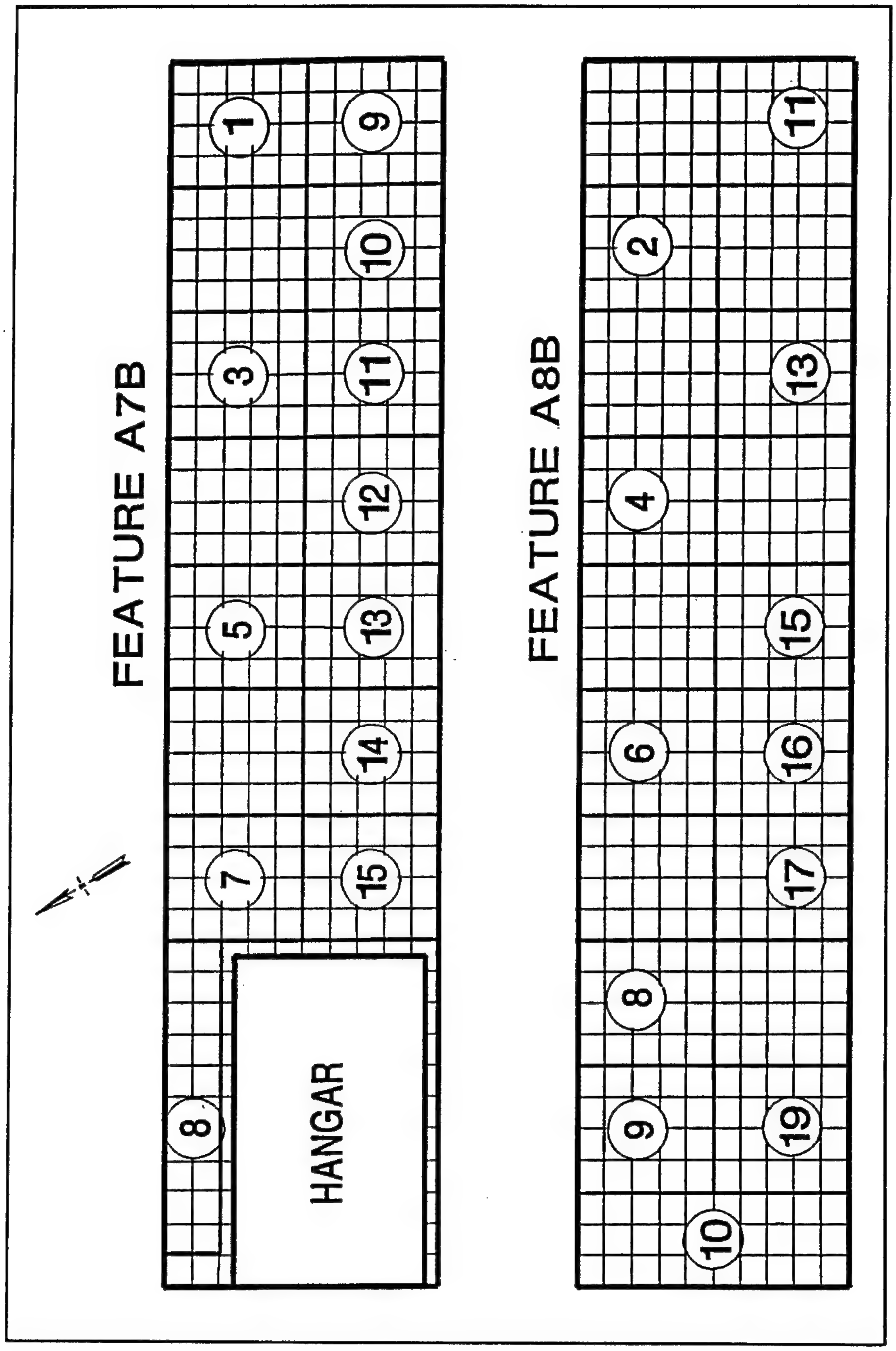


Figure 2. (Sheet 5 of 9)

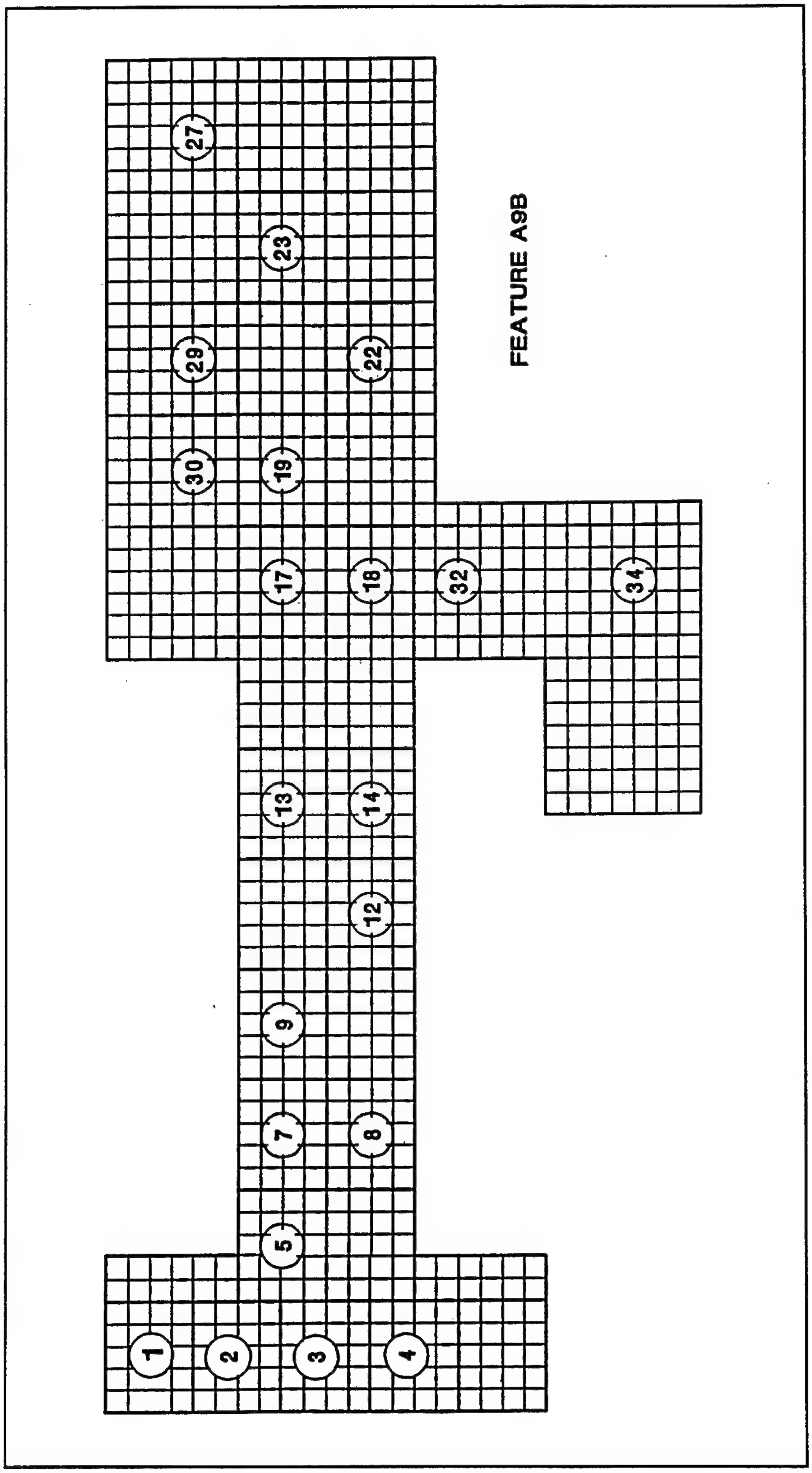


Figure 2. (Sheet 6 of 9)

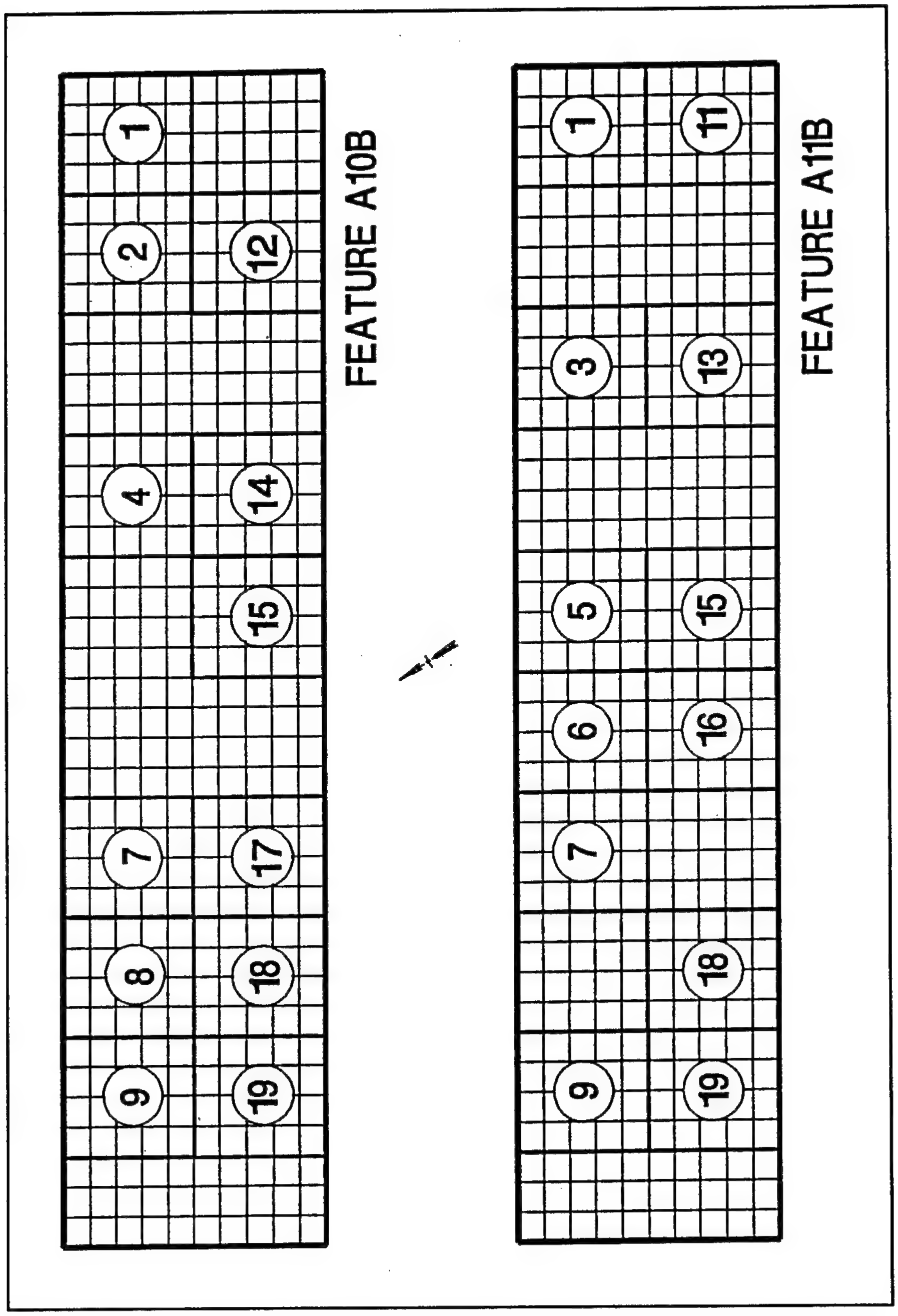


Figure 2. (Sheet 7 of 9)

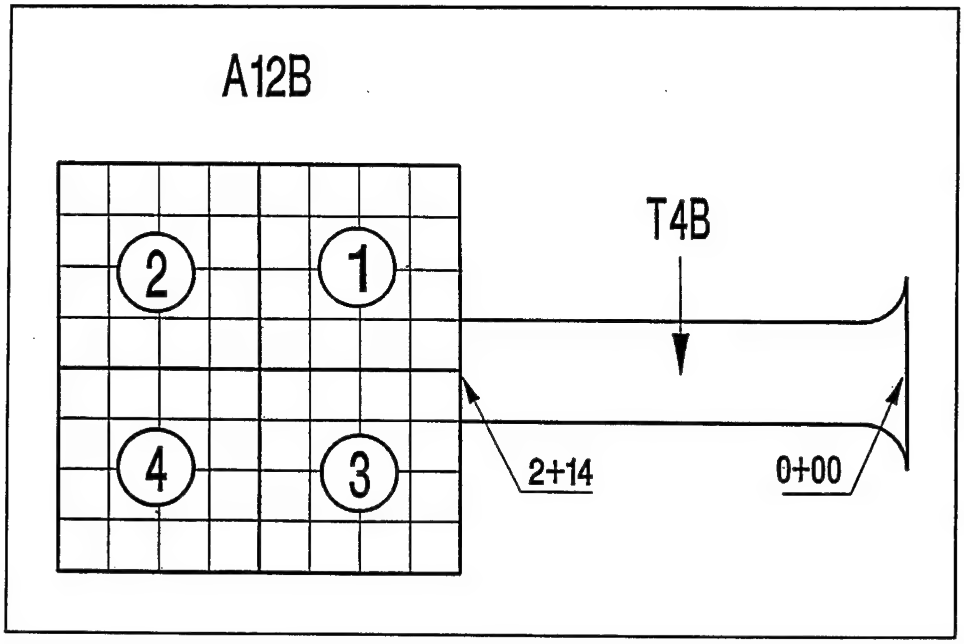


Figure 2. (Sheet 8 of 9)

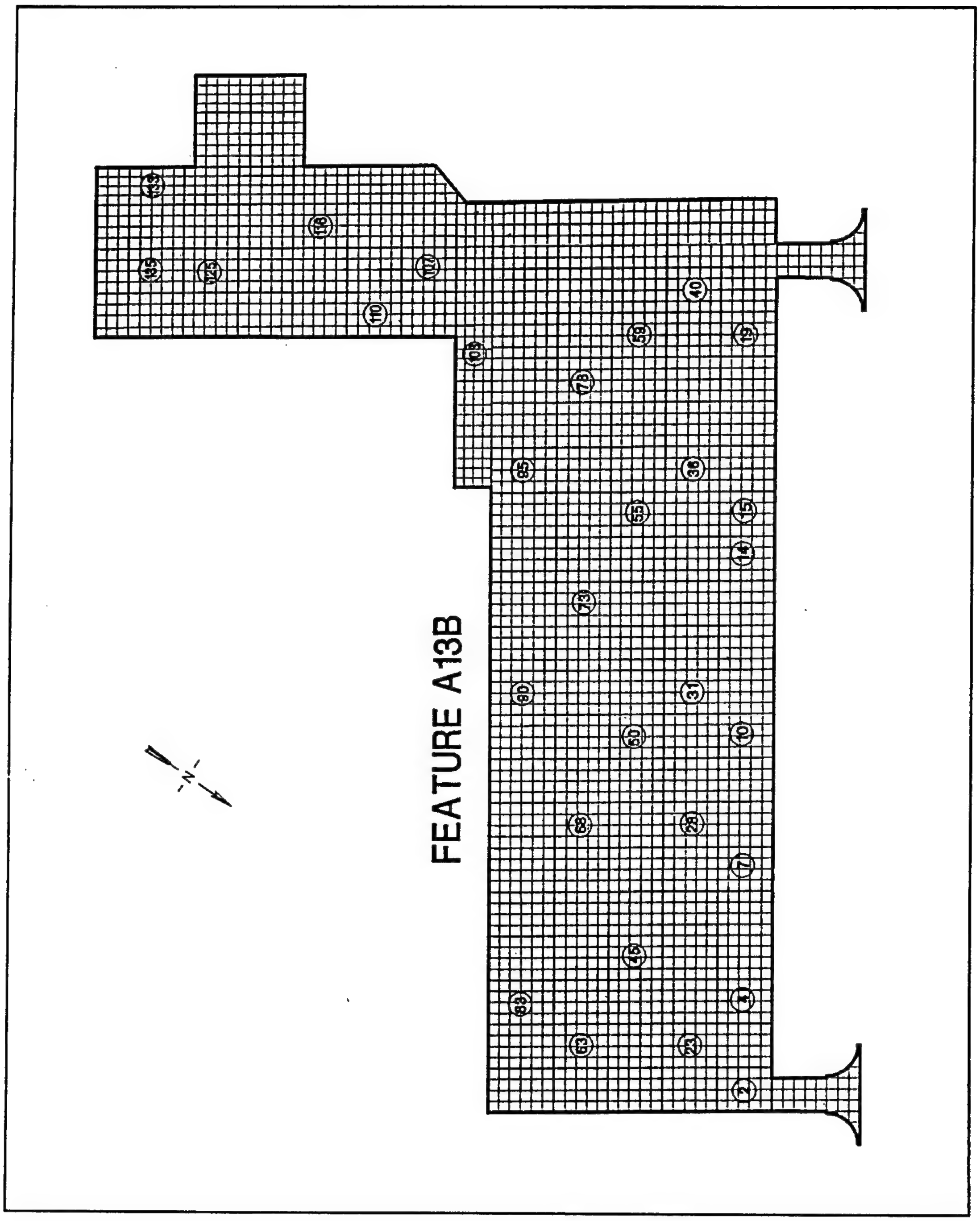


Figure 2. (Sheet 9 of 9)

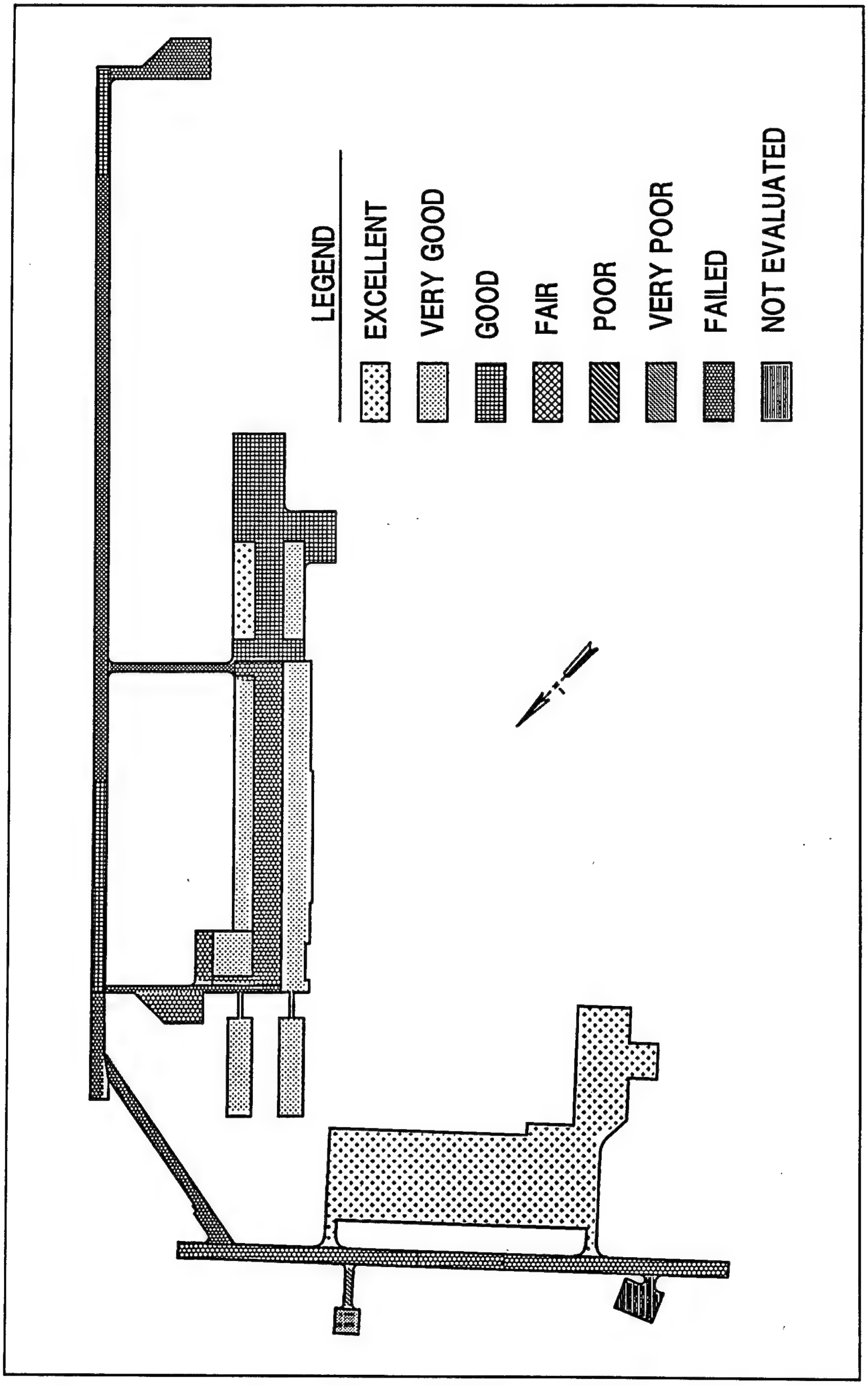


Figure 3. Pavement condition rating summary

Table C1
Pavement Condition Survey Results

Feature	Sample Unit	Station From	Station To	PCI	Rating	Overall PCI	Overall Rating
Runway 13-31							
R1A	1	0+00 (0+00)	0+30 (1+00)	1	Failed	3	Failed
	2	0+30 (1+00)	0+61 (2+00)	5	Failed		
	3	0+61 (2+00)	0+91 (3+00)	2	Failed		
	4	0+91 (3+00)	1+22 (4+00)	3	Failed		
	5	1+22 (4+00)	1+52 (5+00)	5	Failed		
R2A	6	1+52 (5+00)	1+83 (6+00)	40	Poor	58	Good
	7	1+83 (6+00)	2+13 (7+00)	61	Good		
	8	2+13 (7+00)	2+44 (8+00)	64	Good		
	9	2+44 (8+00)	2+74 (9+00)	64	Good		
	10	2+74 (9+00)	3+05 (10+00)	64	Good		
R3A	11	3+05 (10+00)	3+35 (11+00)	64	Good	59	Good
	12	3+35 (11+00)	3+66 (12+00)	64	Good		
	13	3+66 (12+00)	3+96 (13+00)	64	Good		
	14	3+96 (13+00)	4+27 (14+00)	64	Good		
	15	4+27 (14+00)	4+57 (15+00)	42	Fair		
R4A	18	5+18 (17+00)	5+49 (18+00)	62	Good	55	Fair
	20	5+79 (19+00)	6+10 (20+00)	64	Good		
	22	6+40 (21+00)	6+71 (22+00)	64	Good		
	26	7+62 (25+00)	7+92 (26+00)	53	Fair		
	28	8+23 (27+00)	8+53 (28+00)	54	Fair		
	30	8+84 (29+00)	9+14 (30+00)	55	Fair		
	32	9+45 (31+00)	9+75 (32+00)	36	Poor		
	34	10+06 (33+00)	10+36 (34+00)	42	Fair		
	36	10+67 (35+00)	10+97 (36+00)	57	Good		
	38	11+28 (37+00)	11+58 (38+00)	64	Good		
R5A	42	12+50 (41+00)	12+80 (42+00)	57	Good	55	Fair
	43	12+80 (42+00)	13+11 (43+00)	51	Fair		
	44	13+11 (43+00)	13+41 (44+00)	48	Fair		
	45	13+41 (44+00)	13+72 (45+00)	64	Good		
	46	13+72 (45+00)	14+02 (46+00)	58	Good		
R6A	47	14+02 (46+00)	14+33 (47+00)	49	Fair	59	Good
	48	14+33 (47+00)	14+63 (48+00)	59	Good		
	49	14+63 (48+00)	14+94 (49+00)	63	Good		
	50	14+94 (49+00)	15+24 (50+00)	64	Good		
	51	15+24 (50+00)	15+54 (51+00)	64	Good		
Connecting Taxiway							
T1A	1	0+00 (0+00)	0+30 (1+00)	5	Failed	3	Failed
	2	0+30 (1+00)	0+61 (2+00)	5	Failed		
	4	0+91 (3+00)	1+22 (4+00)	1	Failed		
	5	1+22 (4+00)	1+52 (5+00)	3	Failed		
	7	1+83 (6+00)	2+13 (7+00)	5	Failed		
	8	2+13 (7+00)	2+44 (8+00)	3	Failed		
	10	2+74 (9+00)	3+05 (10+00)	5	Failed		
North Taxiway							
T2A	1	0+00 (0+00)	0+30 (1+00)	1	Failed	3	Failed
	3	0+61 (2+00)	0+91 (3+00)	2	Failed		
	4	0+91 (3+00)	1+22 (4+00)	3	Failed		
	5	1+22 (4+00)	1+52 (5+00)	5	Failed		
	7	1+83 (6+00)	2+13 (7+00)	5	Failed		

(Sheet 1 of 5)

Table C1 (Continued)							
Feature	Sample Unit	Station		PCI	Rating	Overall	
		From	To			PCI	Rating
Midfield Taxiway							
T3A	1 2 3	0+00 (0+00) 0+30 (1+00) 0+61 (2+00)	0+30 (1+00) 0+61 (2+00) 0+91 (3+00)	47 48 52	Fair Fair Fair	49	Fair
Compass Swing Base Taxiway							
T4B	1 2	0+00 (0+00) 0+30 (1+00)	0+30 (1+00) 0+61 (2+00)	24 20	Very Poor Very Poor	22	Very Poor
Alpha Lane							
T5A	1 3 5 11 13 15 17 19 21 23 24 27	0+00 (0+00) 0+61 (2+00) 0+91 (4+00) 3+05 (10+00) 3+66 (12+00) 4+27 (14+00) 4+88 (16+00) 5+49 (18+00) 6+10 (20+00) 6+71 (22+00) 7+01 (23+00) 7+92 (26+00)	0+30 (1+00) 0+91 (3+00) 1+52 (5+00) 3+35 (11+00) 3+96 (13+00) 4+57 (15+00) 5+18 (17+00) 5+79 (19+00) 6+40 (21+00) 7+01 (23+00) 7+32 (24+00) 8+23 (27+00)	5 5 5 5 5 5 5 5 5 5 5 5	Failed Failed Failed Failed Failed Failed Failed Failed Failed Failed Failed Failed	5	Failed
North Warm-up Apron							
A1B	1 2 4 6 7	-- -- -- -- --	-- -- -- -- --	5 5 5 5 5	Failed Failed Failed Failed Failed	5	Failed
South Warm-up Apron							
A2B	1 2 3 4 5 6 7	-- -- -- -- -- -- --	-- -- -- -- -- -- --	1 1 3 5 5 5 5	Failed Failed Failed Failed Failed Failed Failed	3	Failed
Hover Lane							
A3B	2 4 5 6 9 11 12 15	-- -- -- -- -- -- -- --	-- -- -- -- -- -- -- --	4 5 5 3 5 5 5 5	Failed Failed Failed Failed Failed Failed Failed Failed	4	Failed
(Sheet 2 of 5)							

Table C1 (Continued)							
		Station				Overall	
Feature	Sample Unit	From	To	PCI	Rating	PCI	Rating
Parking Apron							
A4B	1	--	--	86	Excellent	82	Very Good
	2	--	--	78	Very Good		
	3	--	--	83	Very good		
	4	--	--	88	Excellent		
	5	--	--	88	Excellent		
	6	--	--	81	Very Good		
	7	--	--	81	Very Good		
	8	--	--	87	Excellent		
	9	--	--	72	Very Good		
Parking Apron							
A5B	2	--	--	77	Very Good	83	Very Good
	3	--	--	67	Good		
	5	--	--	86	Excellent		
	6	--	--	84	Very Good		
	7	--	--	80	Very Good		
	9	--	--	84	Very Good		
	10	--	--	88	Excellent		
	11	--	--	88	Excellent		
	13	--	--	88	Excellent		
	14	--	--	88	Excellent		
	15	--	--	85	Very Good		
	17	--	--	88	Excellent		
	19	--	--	83	Very Good		
Parking Apron							
A6B	1	--	--	76	Very Good	76	Very Good
	3	--	--	85	Very Good		
	6	--	--	68	Good		
	8	--	--	75	Very Good		
	9	--	--	63	Good		
	12	--	--	76	Very Good		
	13	--	--	72	Very Good		
	15	--	--	70	Good		
	17	--	--	74	Very Good		
	18	--	--	84	Very Good		
	20	--	--	85	Very Good		
	21	--	--	88	Excellent		
Parking Apron							
A7B	1	--	--	81	Very Good	80	Very Good
	3	--	--	79	Very Good		
	5	--	--	78	Very Good		
	7	--	--	90	Excellent		
	8	--	--	81	Very Good		
	10	--	--	72	Very Good		
	12	--	--	75	Very Good		
	14	--	--	85	Very Good		
	15	--	--	84	Very Good		
(Sheet 3 of 5)							

Table C1 (Continued)

Feature	Sample Unit	Station From	Station To	PCI	Rating	Overall PCI	Overall Rating
Parking Apron							
A8B	2	--	--	83	Very Good	86	Excellent
	4	--	--	88	Excellent		
	6	--	--	93	Excellent		
	8	--	--	86	Excellent		
	9	--	--	79	Very Good		
	11	--	--	79	Very Good		
	13	--	--	88	Excellent		
	15	--	--	83	Very Good		
	16	--	--	88	Excellent		
	17	--	--	93	Excellent		
	19	--	--	93	Excellent		
Parking Apron							
A9B	1	--	--	46	Fair	66	Good
	2	--	--	25	Very Poor		
	3	--	--	51	Fair		
	4	--	--	58	Good		
	5	--	--	49	Fair		
	7	--	--	65	Good		
	8	--	--	63	Good		
	9	--	--	58	Good		
	12	--	--	54	Fair		
	13	--	--	47	Fair		
	14	--	--	71	Very Good		
	17	--	--	83	Very Good		
	18	--	--	68	Good		
	19	--	--	83	Very Good		
	22	--	--	78	Very Good		
	23	--	--	91	Excellent		
	27	--	--	78	Very Good		
	29	--	--	83	Very Good		
	30	--	--	83	Very Good		
	32	--	--	82	Very Good		
	34	--	--	76	Very Good		
East Rotary Wing Parking Apron							
A10B	1	--	--	84	Very Good	85	Very Good
	2	--	--	88	Excellent		
	4	--	--	88	Excellent		
	7	--	--	88	Excellent		
	8	--	--	88	Excellent		
	9	--	--	88	Excellent		
	12	--	--	84	Very Good		
	14	--	--	88	Excellent		
	15	--	--	88	Excellent		
	17	--	--	81	Very Good		
	18	--	--	88	Excellent		
	19	--	--	73	Very Good		

(Sheet 4 of 5)

Table C1 (Continued)

Feature	Sample Unit	Station		PCI	Rating	Overall	
		From	To			PCI	Rating
West Rotary Wing Parking Apron							
A11B	1	--	--	60	Good	81	Very Good
	3	--	--	79	Very Good		
	5	--	--	81	Very Good		
	6	--	--	81	Very Good		
	7	--	--	85	Very Good		
	9	--	--	88	Excellent		
	11	--	--	74	Very Good		
	13	--	--	84	Very Good		
	15	--	--	88	Excellent		
	16	--	--	86	Excellent		
	18	--	--	85	Very Good		
	19	--	--	88	Excellent		
Compass Swing Base							
A12B	1	--	--	74	Very Good	79	Very Good
	2	--	--	78	Very Good		
	3	--	--	85	Very Good		
	4	--	--	79	Very Good		
Avum Hangar Apron							
A13B	2	--	--	79	Very Good	92	Excellent
	4	--	--	90	Excellent		
	7	--	--	89	Excellent		
	10	--	--	98	Excellent		
	14	--	--	85	Very Good		
	15	--	--	91	Excellent		
	19	--	--	95	Excellent		
	23	--	--	89	Excellent		
	28	--	--	95	Excellent		
	31	--	--	92	Excellent		
	36	--	--	98	Excellent		
	40	--	--	95	Excellent		
	45	--	--	93	Excellent		
	50	--	--	95	Excellent		
	55	--	--	88	Excellent		
	59	--	--	92	Excellent		
	63	--	--	98	Excellent		
	68	--	--	94	Excellent		
	73	--	--	95	Excellent		
	78	--	--	98	Excellent		
	83	--	--	88	Excellent		
	90	--	--	95	Excellent		
	95	--	--	92	Excellent		
	103	--	--	98	Excellent		
	107	--	--	94	Excellent		
	110	--	--	91	Excellent		
	116	--	--	92	Excellent		
	125	--	--	95	Excellent		
	131	--	--	88	Excellent		
	133	--	--	94	Excellent		

(Sheet 5 of 5)

Table C2
1993 PCI Compared with 1995 PCI

Feature	1993 PCI	1995 PCI	Change in PCI	1993 Rating	1995 Rating	Type Pavement
R1A	3	3	0	Failed	Failed	AC
R2A	74	58	-16	Very Good	Good	AC
R3A	70	59	-11	Good	Good	AC
R4A	72	55	-17	Very Good	Fair	AC
R5A	71	55	-16	Very Good	Fair	AC
R6A	74	59	-15	Very Good	Good	AC
T1A	2	3	+1	Failed	Failed	AC
T2A	17	3	-14	Very Poor	Failed	AC
T3A	68	49	-19	Good	Fair	PCC
T4B	28	22	-6	Poor	Very Poor	AC
T5A	24	5	-19	Very Poor	Failed	AC
A1B	17	5	-12	Very Poor	Failed	AC
A2B	2	3	+1	Failed	Failed	AC
A3B	26	4	-22	Poor	Failed	AC
A4B	97	82	-15	Excellent	Very Good	PCC
A5B	97	83	-14	Excellent	Very Good	PCC
A6B	95	76	-19	Excellent	Very Good	PCC
A7B	94	80	-14	Excellent	Very Good	PCC
A8B	93	86	-7	Excellent	Excellent	PCC
A9B	83	66	-17	Very Good	Good	PCC
A10B	88	85	-3	Excellent	Very Good	PCC
A11B	84	81	-3	Very Good	Very Good	PCC
A12B	88	79	-9	Excellent	Very Good	PCC
A13B	100	92	-8	Excellent	Excellent	PCC

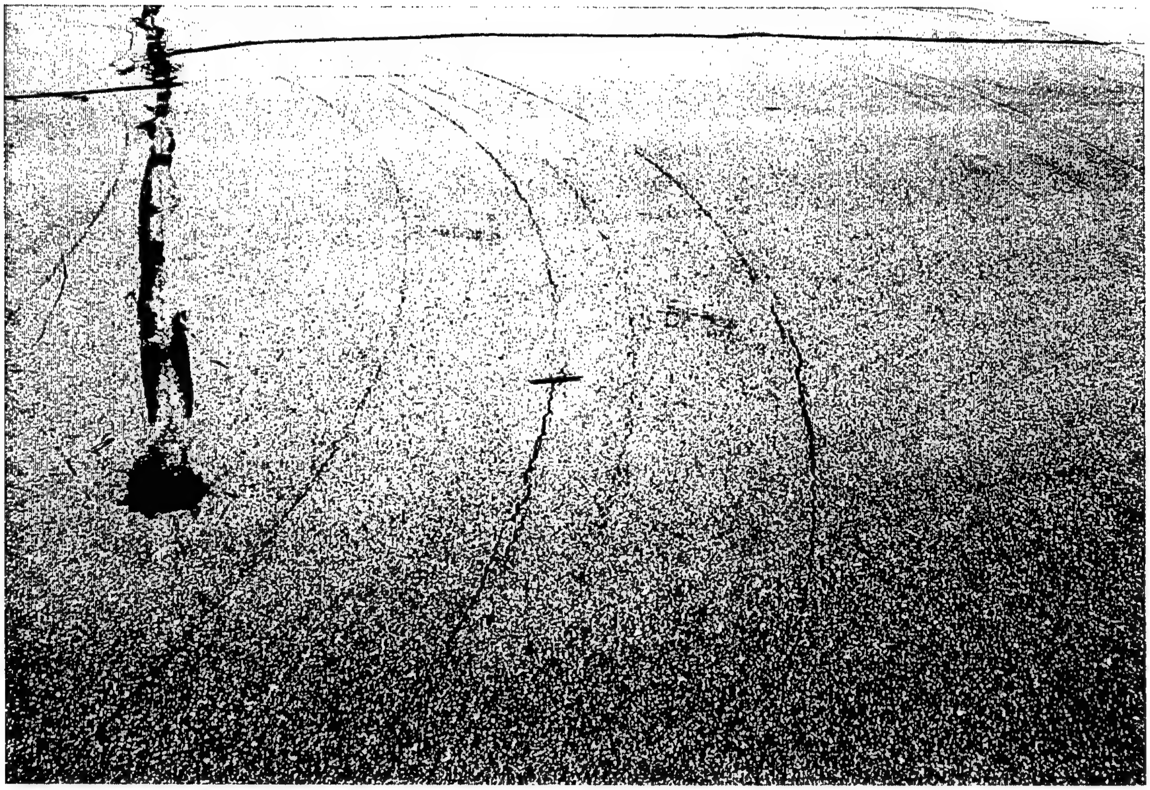


Photo C1. Cracks caused by turning C-130 on Runway 13-31

Photo C2. Patch of slippage crack on Runway 13-31

Photo C3. Medium-severity rutting and alligator cracking on Runway 13-31

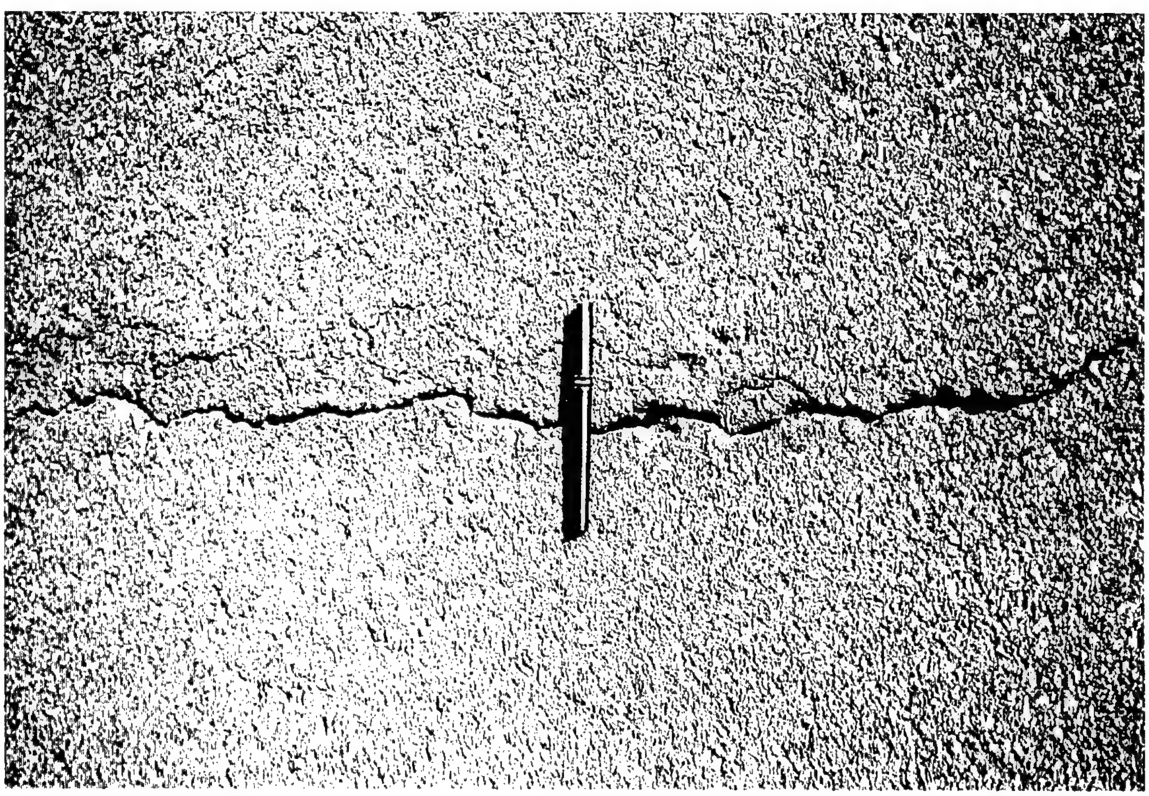


Photo C4. Medium-severity longitudinal and transverse crack

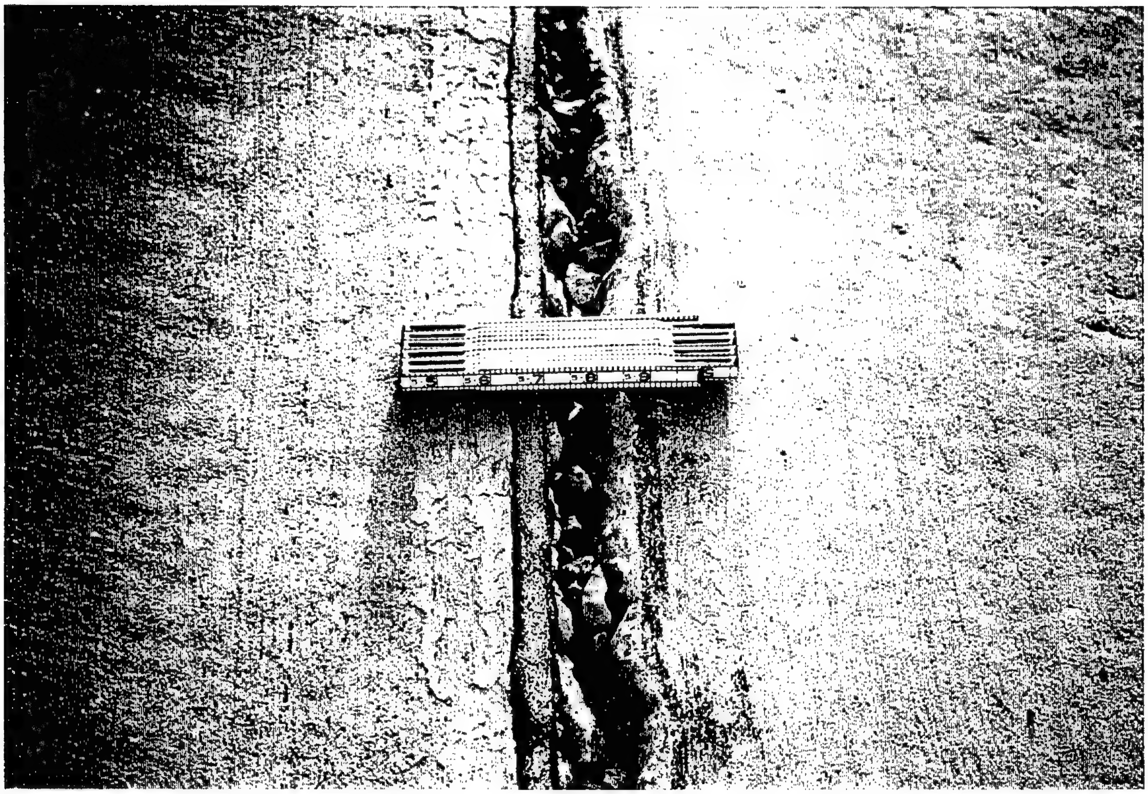


Photo C5. High-severity joint sealant on the Midfield Taxiway

Photo C6. High-severity block cracking on the Alpha Lane (Old Runway 4-22)

Photo C7. High-severity weathering/raveling on the Hover Lane

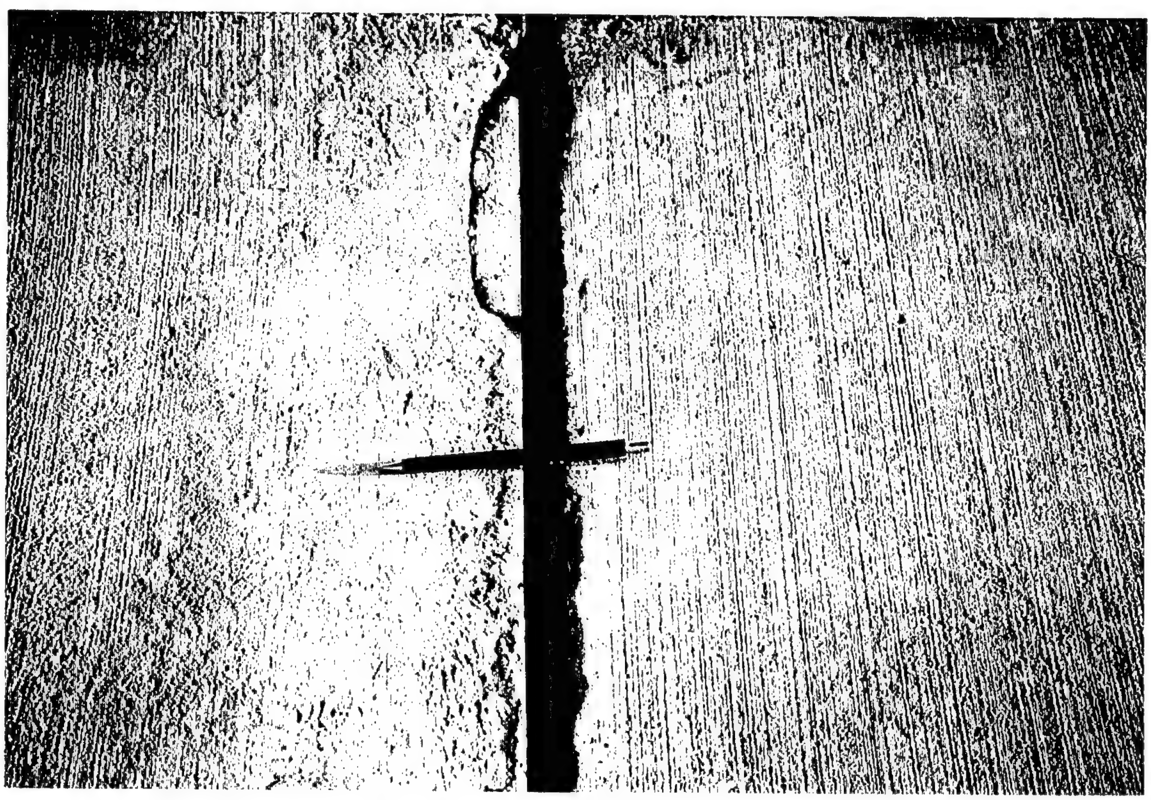


Photo C8. Typical low-severity joint spall on the Avum Hanger Apron

Photo C9. High-severity joint spall on the Parking Apron

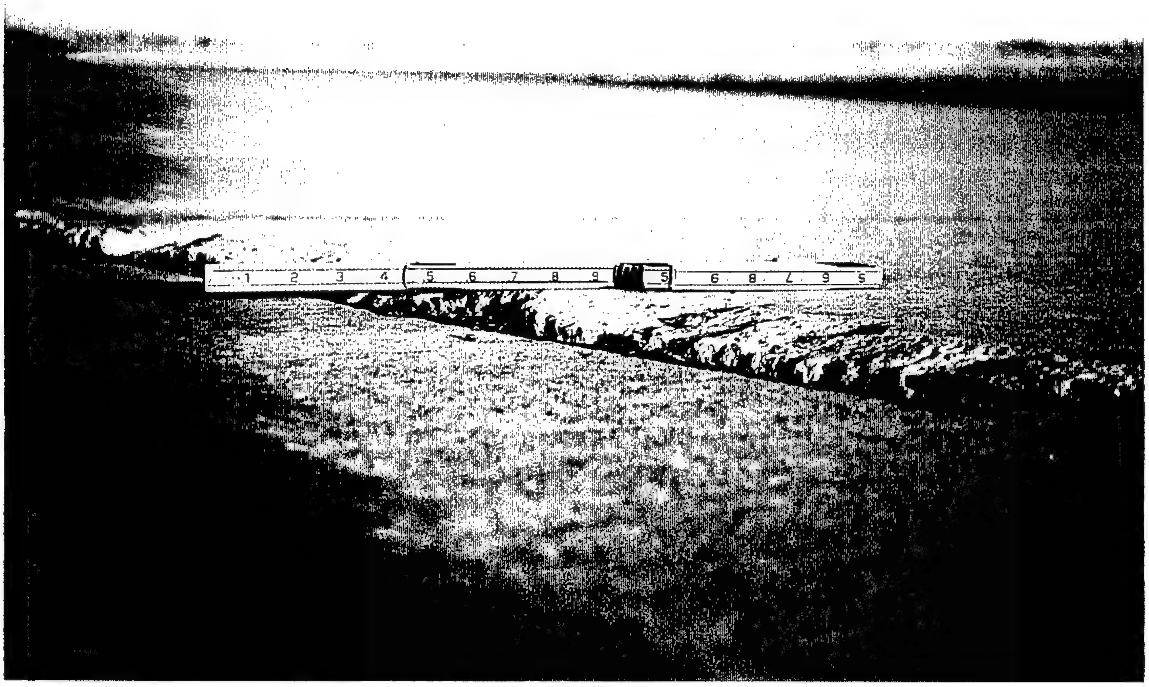


Photo C10. High-severity faulting on the Parking Apron

Appendix D Structural Analysis

General

The projected performance of the airfield pavement facilities was analyzed for a 20-year analysis period. The traffic for this period was based on the information provided by the airfield commander.

The critical aircraft operating on the fixed-wing pavements was determined to be the C-130 aircraft. The critical aircraft operating on the rotary-wing pavements was determined to be the CH-47 aircraft. Table D1 presents the critical aircraft computation results for the pavements.

The operational ACN was determined based on the critical aircraft; the 61 Mg (135-kip) C-130 aircraft on the fixed-wing pavements and the 23 Mg (50-kip) CH-47 aircraft on the rotary-wing pavements. The results showing the ACN values for each pavement type and subgrade strength are shown in Table D2.

During wartime, many aircraft are allowed to carry heavier loads than during peacetime, which means that the aircraft would have a higher ACN because of the higher loading and would cause more damage than in peacetime thereby reducing the life of the pavement. A mobilization ACN can be determined from the appropriate ACN-PCN curve presented in ETL 1110-3-394 (Headquarters, Department of the Army 1991b). A C-130, ACN-PCN curve is shown in Figure D1 and a CH-47 ACN-PCN curve is shown in Figure D2. During contingency planning, there is often the need to determine the largest possible aircraft that can safely land on the airfield. Generally, the length of the runway controls the size of the aircraft that can safely land. Minimum take-off distances for maximum take-off weights of aircraft are also given in ETL 1110-3-394 (Headquarters, Department of the Army 1991b). Once the aircraft is known, the ACN of that aircraft can be determined from the ACN-PCN curve and then the effect of the higher loads on the airfield can be determined from the ACN/PCN ratio and pavement life utilized or passes-till-failure curves. Specific aircraft mobilization traffic requirements are contained in classified mobilization plans and are not included in this report.

ACN-PCN Method of Reporting Pavement Structural Condition

The ACN-PCN method is used to provide a means of reporting the structural evaluation of a pavement. This procedure is a standardized International Civil Aviation Organization (ICAO) method. The ACN is used to express the effect of individual aircraft on different pavements by a single unique number which varies according to pavement type and subgrade strength without specifying a particular pavement thickness. Conversely, the PCN of a pavement can be expressed by a single unique number without specifying a particular aircraft. The ACN and PCN values are defined as follows:

a. ACN - A number which expresses the relative structural effect of an aircraft on different pavement types for specified standard subgrade strengths in terms of a standard single-wheel load.

b. PCN - A number which expresses the relative load-carrying capacity of a pavement for a given pavement life in terms of a standard single-wheel load.

The ACN-PCN method is structured so that the structural evaluation of a pavement for a particular aircraft can be accomplished by using the ratio of the aircraft ACN to the pavement PCN. For a given pavement life and a given number of operations for a particular aircraft there is a relationship between the ACN/PCN ratio and the percent of pavement life used by the applied traffic. For a given ACN/PCN ratio, a relationship exists for the number of operations that will produce failure of the pavement. These relationships provide a method for evaluating a pavement for allowable load depending on acceptable degree of damage to the pavement or an allowable number of operations of a particular aircraft to cause failure of a pavement. For aircraft having an ACN equal to the PCN, the predicted failure of the pavement would equal the design life of the pavement. Aircraft having ACN's higher than the pavement PCN would overload the pavement and decrease the life of the pavement. Likewise, if the ACN of the operational aircraft is less than the pavement PCN, the life of the pavement would be greater than the design life. If the operational ACN is greater than the pavement PCN and a decrease in pavement life is not acceptable, then structural improvement of the pavement is required to bring the pavement PCN up to or greater than the operational ACN.

PCN Analysis

Modulus values were input into a computer program to compute the load-carrying capacity of the pavements (PCN) and the overlay thickness require-ments. The PCN for each pavement feature was determined in accordance with TM 5-826-1/AFJMAN 32-1036/DM 21.7 (Headquarters, Departments of the Army, the Air Force, and the Navy Draft). Using the design aircraft and traffic levels for normal operations, and thaw-weakened periods, the

PCN was determined for each pavement feature. The PCN is determined using the allowable gross aircraft load and the subgrade strength category determined from the CBR and k-values obtained through correlations with backcalculated subgrade modulus values. A typical ACN-PCN curve is shown in Figure D1. Table D3 presents a summary of the evaluation of each pavement feature for nonfrost period (May through October) in terms of allowable gross aircraft loadings, PCN, and overlays required to bring the PCN up to the required PCN (ACN of the design aircraft). The APEC presented in Figure 2-1 shows a layout of the airfield pavements and corresponding PCN for each facility determined for the nonfrost period.

An analysis was completed to determine additional strengthening requirements to increase the PCN to equal the current ACN. This increase is based on the traffic presented in Table D1. Although the increase in strength is presented as overlay thickness, several other approaches could be used to increase the strength. A detailed analysis will be required to select and design the most cost-effective repair or improvement alternative. It should be noted that although less than 10-cm (4-in.)-thick AC and 15-cm (6-in.)-thick PCC overlay requirements are indicated in Table D3, the following minimum thicknesses are recommended in TM 5-825-3/AFM 88-6, Chap. 3 (Headquarters, Departments of the Army and the Air Force 1988):

a. 5-cm (2-in.)-thick minimum AC overlay over AC pavements.

b. 10-cm (4-in.)-thick minimum AC overlay over PCC pavements.

c. 15-cm (6-in.)-thick minimum PCC partially or nonbonded overlay.

d. 5 cm (2-in.)-thick minimum PCC fully bonded overlay over PCC pavements.

These minimum overlay requirements are required to control the degree of cracking which will occur in the base pavement (existing pavement) due to the application of the design traffic. If those features needing structural improvements do not receive the required strengthening, the rate of deterioration can be quite rapid leading to damage in all pavement layers. Failure to provide the necessary improvements will generally cause dramatic increases in the cost of later treatments after failure has occurred. It may also cause the pavement to be closed for operation for a considerable period of time.

The PCN codes for the weakest feature within each pavement facility during normal operations are shown in Table D4. The PCN codes include the PCN numerical value, pavement type, subgrade category, allowable tire pressure, and method used to determine the PCN. An example of a PCN code is: 40/F/C/W/T, with 40 expressing the numerical PCN value, F indicating a flexible pavement, C indicating low strength subgrade, W indicating high-allowable tire pressure, and T indicating that the PCN value was obtained by a technical evaluation. Table D5 presents a description of all the letter codes comprising the PCN code. Each PCN assumes that only the design aircraft will be used for the stated number of passes. Once the PCN's were determined, relationships were developed for pavement life and allowable traffic as a function of the ratio of

ACN to PCN. Theoretically, if the PCN is equal to the ACN, the pavement should perform adequately with only routine maintenance through the length of the analysis period. There may be situations when operators have to overload a pavement, i.e., the ACN is greater than the PCN. Pavements can usually support some overload; however, pavement life is reduced. If the PCN equals the ACN, the ratio of the ACN to the PCN (ACN/PCN) equals 1, and the pavement is expected to perform satisfactorily until the end of the analysis period. If the PCN is less than the ACN, ACN/PCN would be greater than 1, and the pavement would be expected to fail before reaching the end of the analysis period. Figures D3 through D10 show the relationships for the allowable passes to failure if the ACN/PCN is known. Thus, if the ACN for mobilization or the ACN for contingency planning divided by the current PCN is 1.5, failure would be expected to occur between 375 and 425 applications for fixed-wing aircraft on flexible pavements, based on Figure D3. Additional examples of how the ACN/PCN figures are used are shown below.

Example Problem

A cargo mission has been assigned to the fixed-wing facility. Aircraft traffic is projected to be 100 passes of a 70-Mg (155-kips) C-130.

a. What is the ACN for the aircraft?

b. Will the fixed-wing facility be overloaded?

c. If the fixed-wing facility is overloaded, how much of the pavement life will be utilized during this mission?

d. Determine the maximum number of C-130 passes before failure?

Solution

The controlling feature on fixed-wing facility is the North Warm-Up Apron (A1B). From Table D4, feature A1B has a PCN code of 11/F/C/W/T, which is not adequate for C-130 aircraft. The C-130 aircraft should be limited to Runway 13-31 and Feature A9B of the PCC portion of the Parking Apron. The controlling feature for the AC runway on the fixed-wing pavements is R3A with a PCN of 40/F/C/W/T, and the controlling feature for rigid fixed-wing pavements is A9B with a PCN of 29/R/C/W/T.

a. From Figure D1, the ACN of a 70-Mg (155-kips) C-130 on a rigid pavement over a low strength subgrade is 32/R/C/W/T.

b. The runway will not be overloaded, the ACN/PCN is 31/40 or 0.8; however, Feature A9B of the Parking Apron will be overloaded. The ACN/PCN for Feature A9B of the Parking Apron is 32/29 or 1.10.

c. From Figure D8, the percent life utilized for a rigid pavement with an ACN/PCN of 1.1 and 100 passes is about 25 percent.

d. From Figure D4, the passes until failure for a rigid ACN/PCN of 1.1 are about 3,000, and from Figure D3, the passes until failure for a flexible ACN/PCN of 0.8 are about 50,000.

A summary of the evaluation of each pavement feature in terms of PCN for the thaw-weakened period (November through April) is shown in Table D4. When a pavement is not properly designed and constructed to withstand the detrimental effects of winter, one or both of the following will occur: nonuniform heave due to ice lenses or loss of strength during a thaw period. Thaw-weakened periods which generally occur during the time period of November through April are identified based on the climatological data shown in Table A1. During this period, several to many cycles of freezing and thawing will occur. Loss of strength will take place during thaw periods in those pavements that have not been properly designed and constructed to prevent such loss. The degree of strength loss depends upon the depth of frost and subsequent thawing. The depth of frost penetration was determined using the Modberg2 computer software. Typical frost codes in the area are an F-1 for base course material and an F-3 for the subgrade material. PCN's for the thaw-weakened periods are provided as guidance to the airfield operator for managing airfield operations during the November through April time frame.

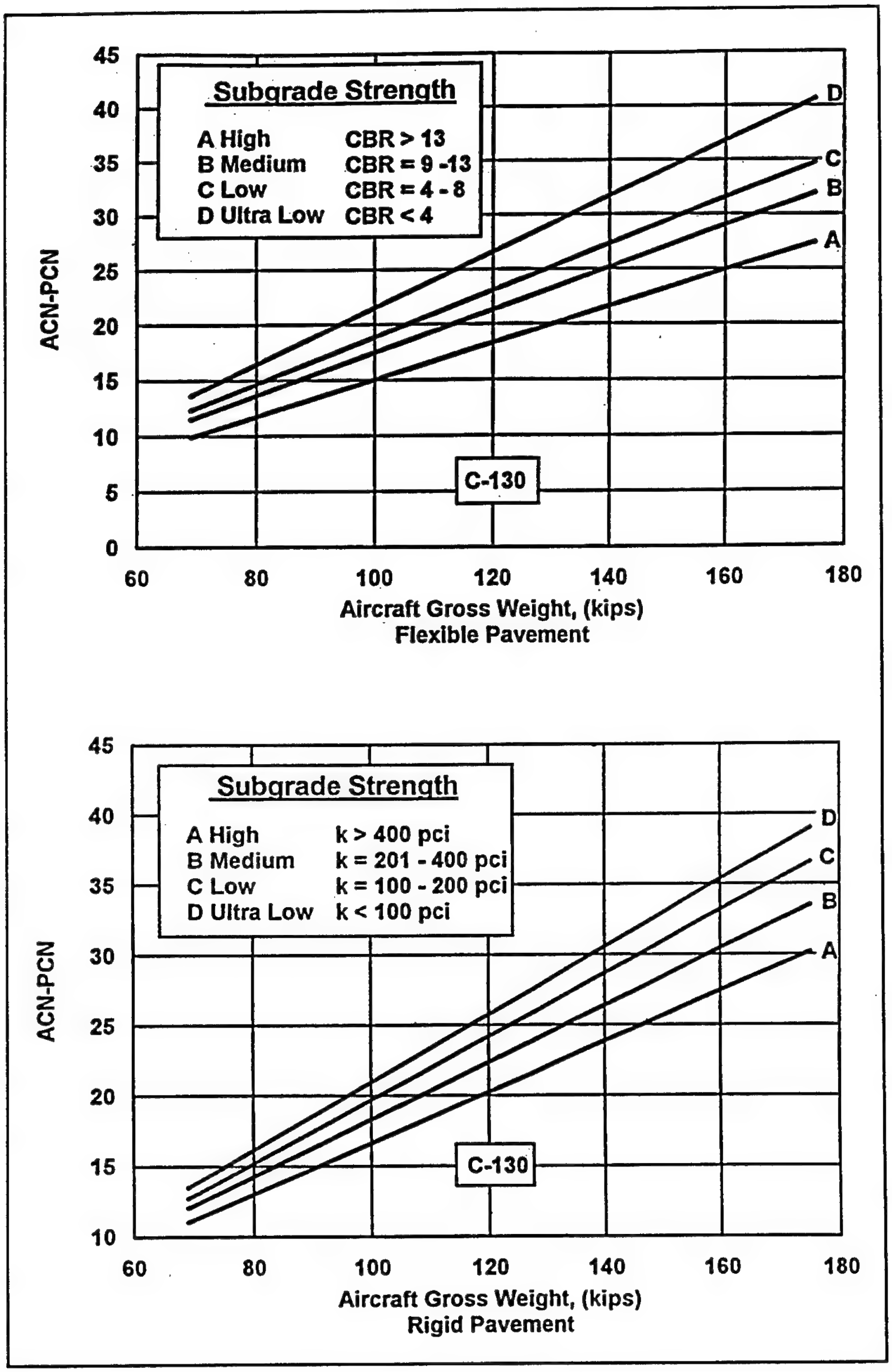


Figure D1. ACN-PCN curves for C-130 aircraft

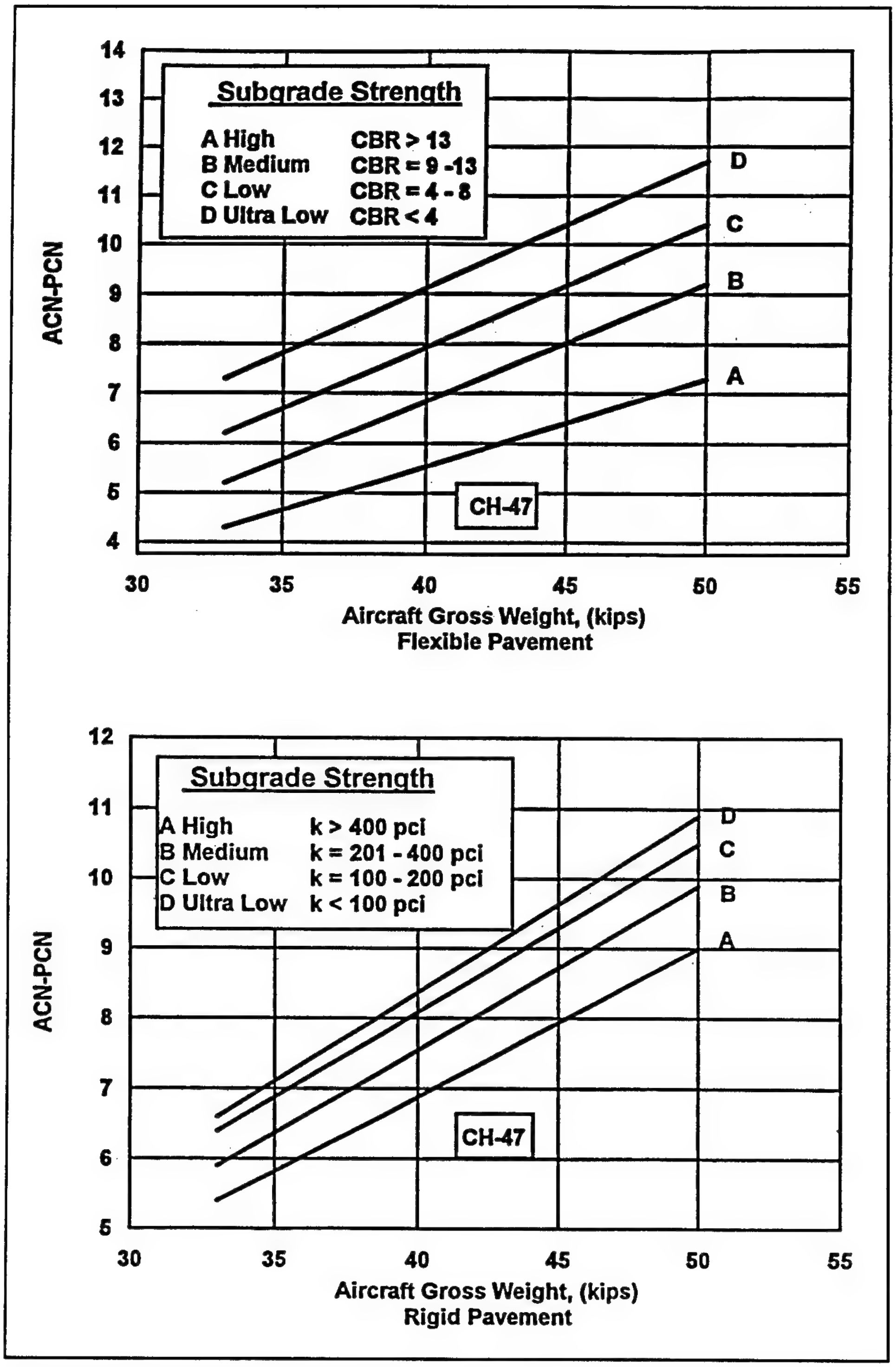


Figure D2. ACN-PCN curves for CH-47 aircraft

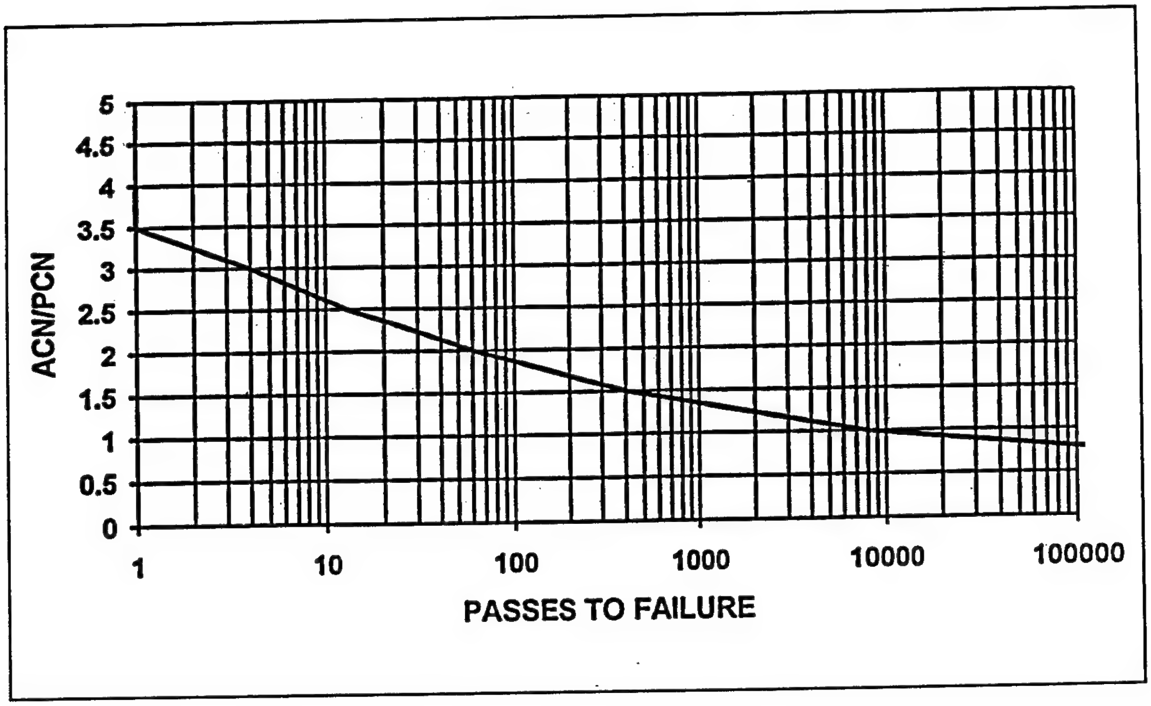


Figure D3. Passes until failure C-130, flexible pavement (nonfrost)

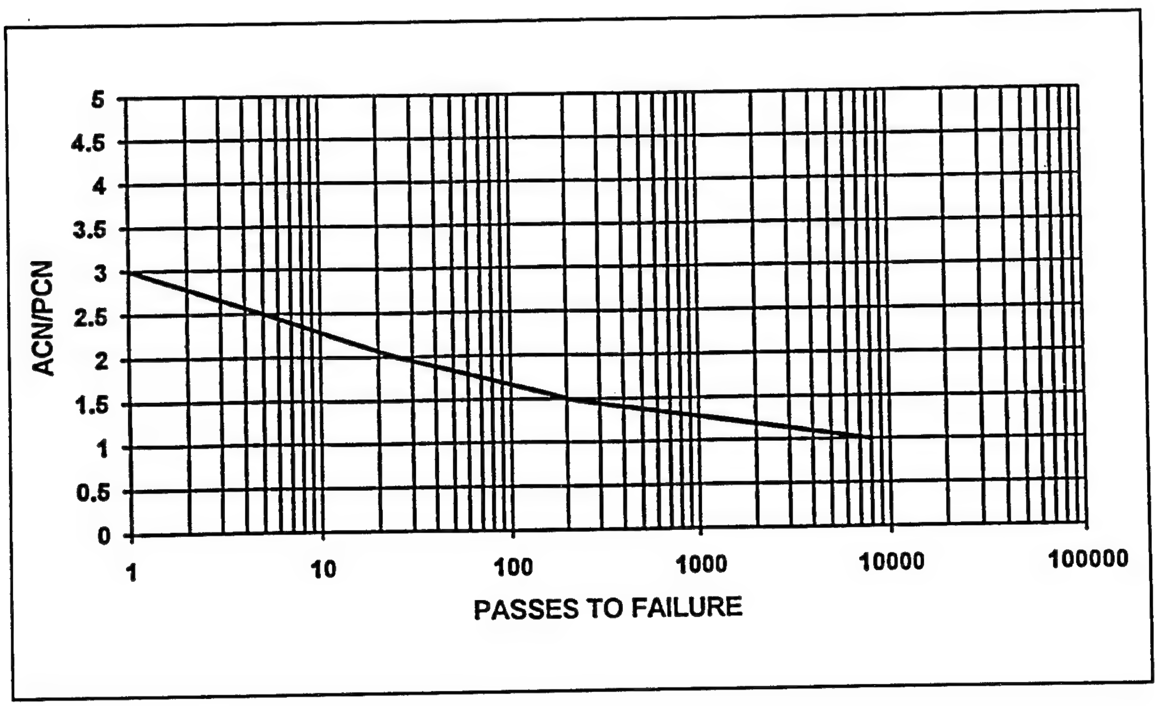


Figure D4. Passes until failure C-130, rigid pavement (nonfrost)

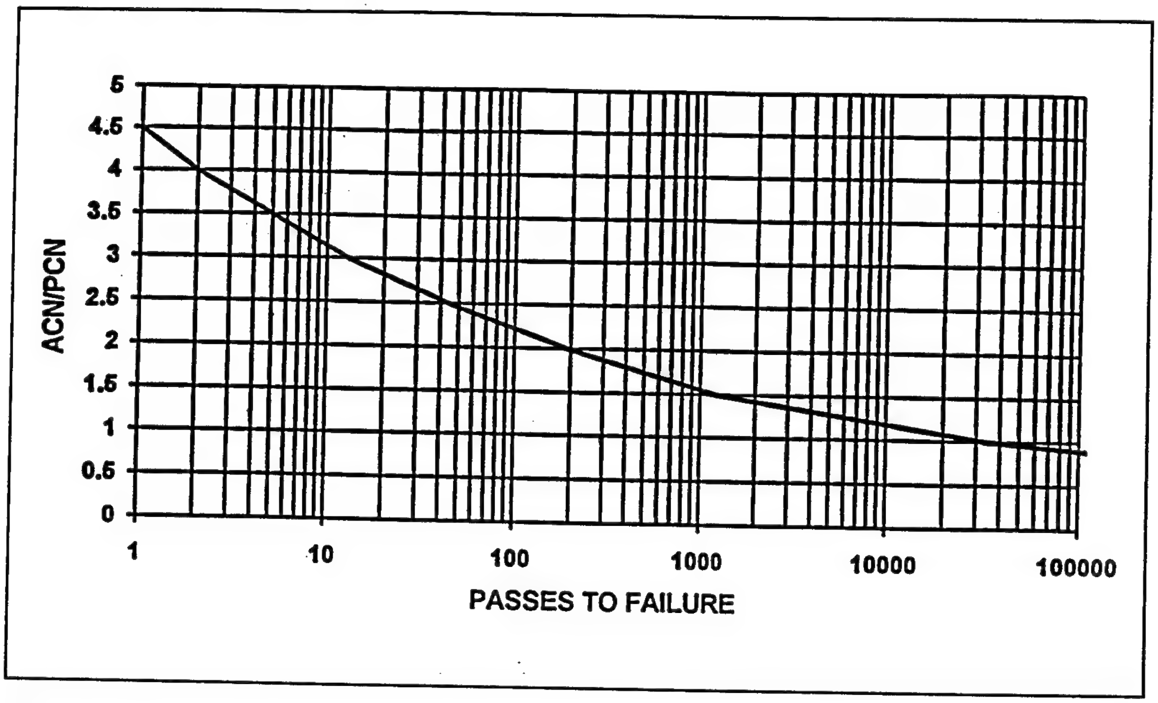


Figure D5. Passes until failure CH-47, flexible pavement (nonfrost)

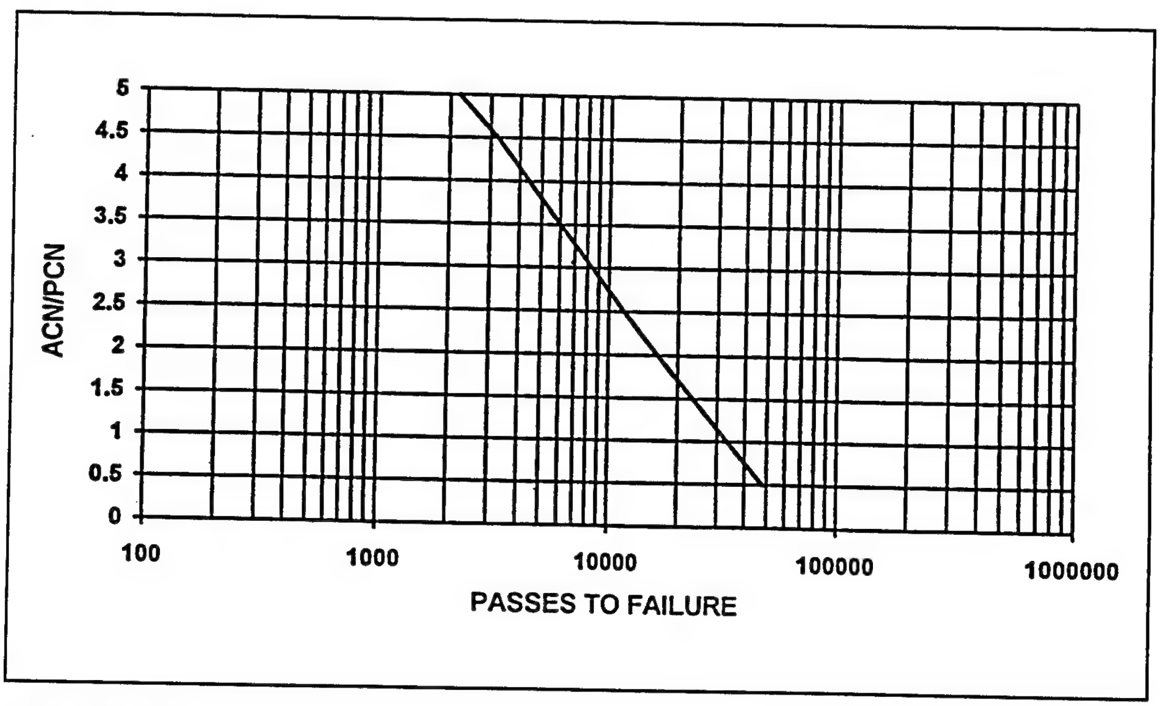


Figure D6. Passes until failure CH-47, rigid pavement (nonfrost)

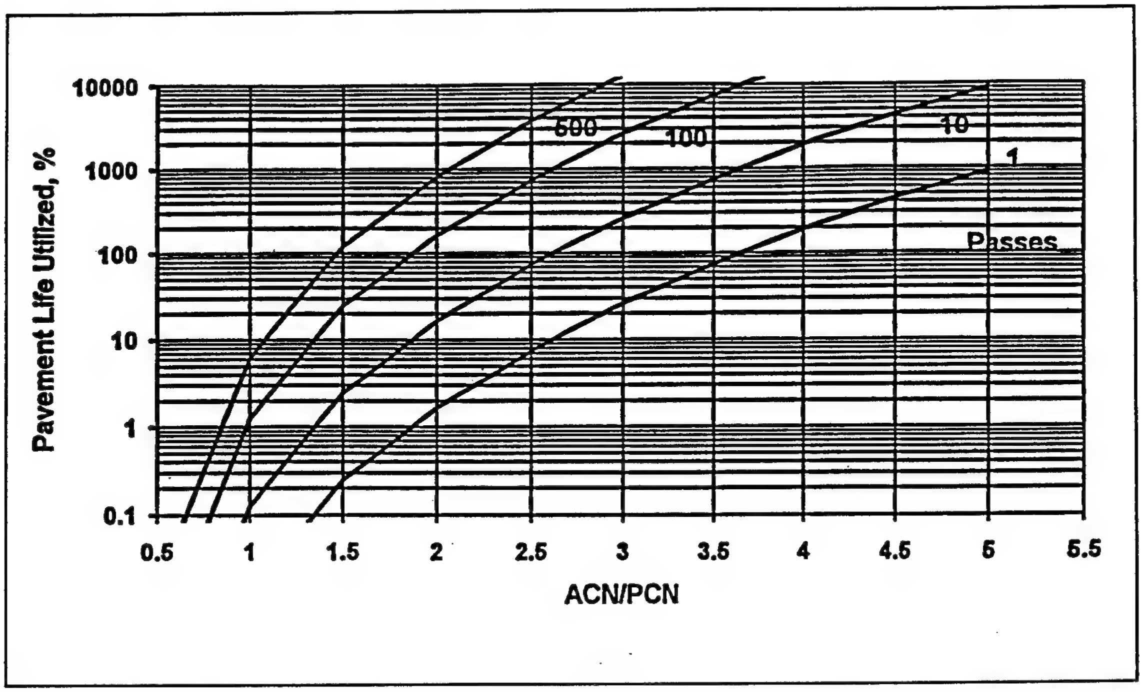


Figure D7. Pavement life utilized C-130, flexible pavement (nonfrost)

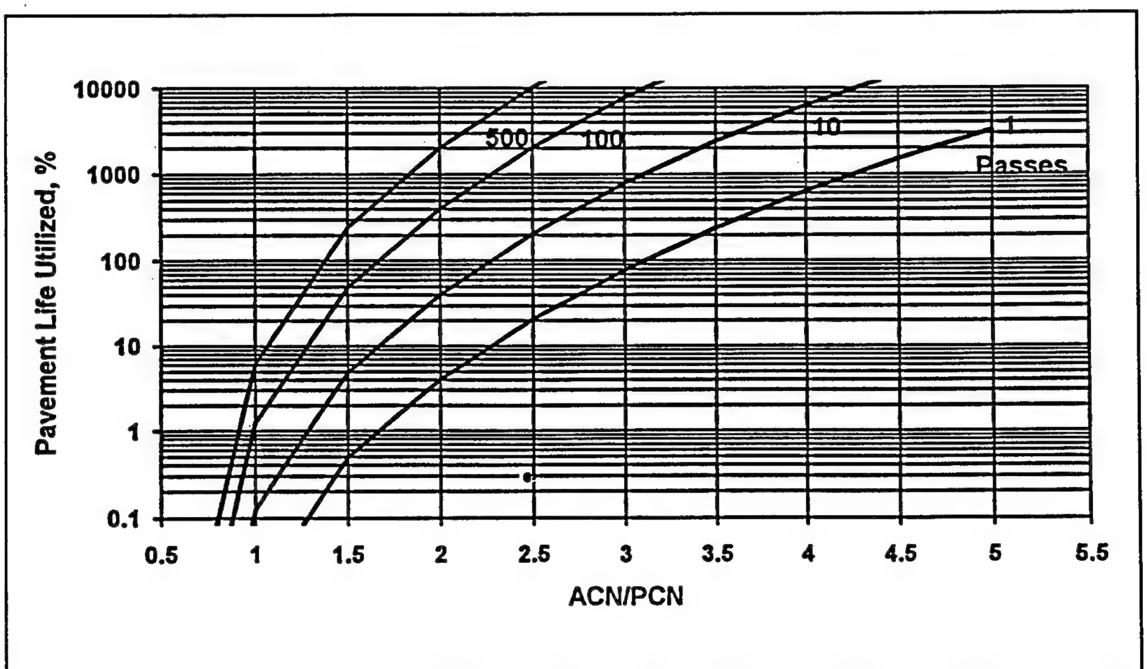


Figure D8. Pavement life utilized C-130, rigid pavement (nonfrost)

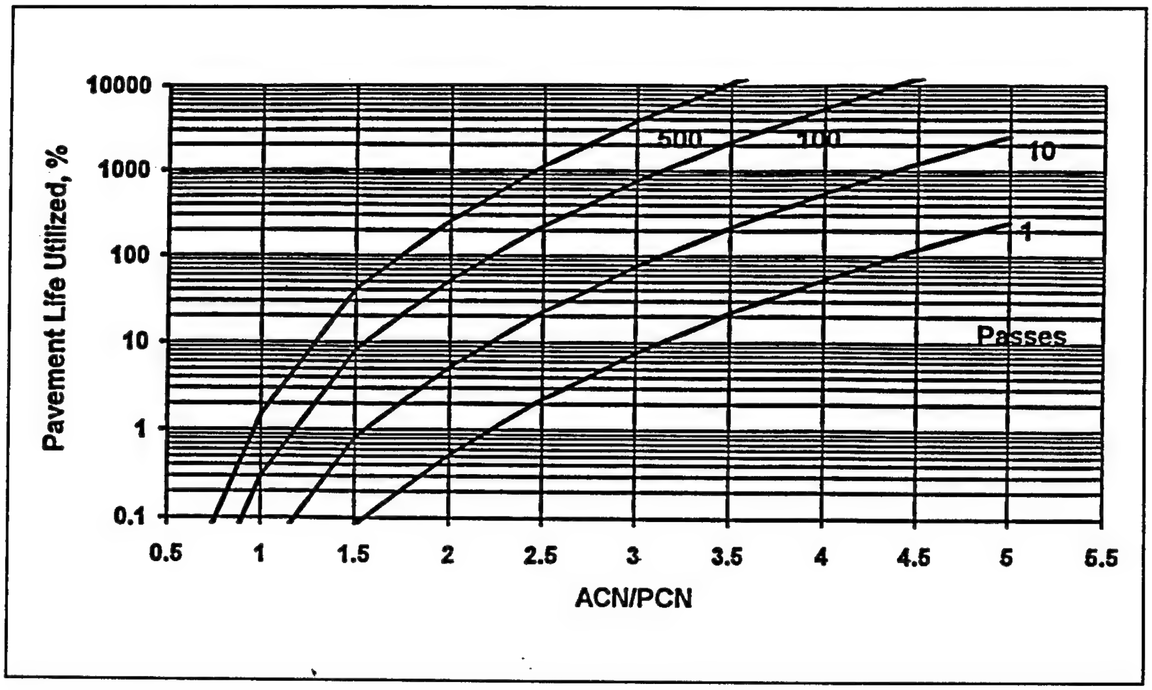


Figure D9. Pavement life utilized CH-47, flexible pavement (nonfrost)

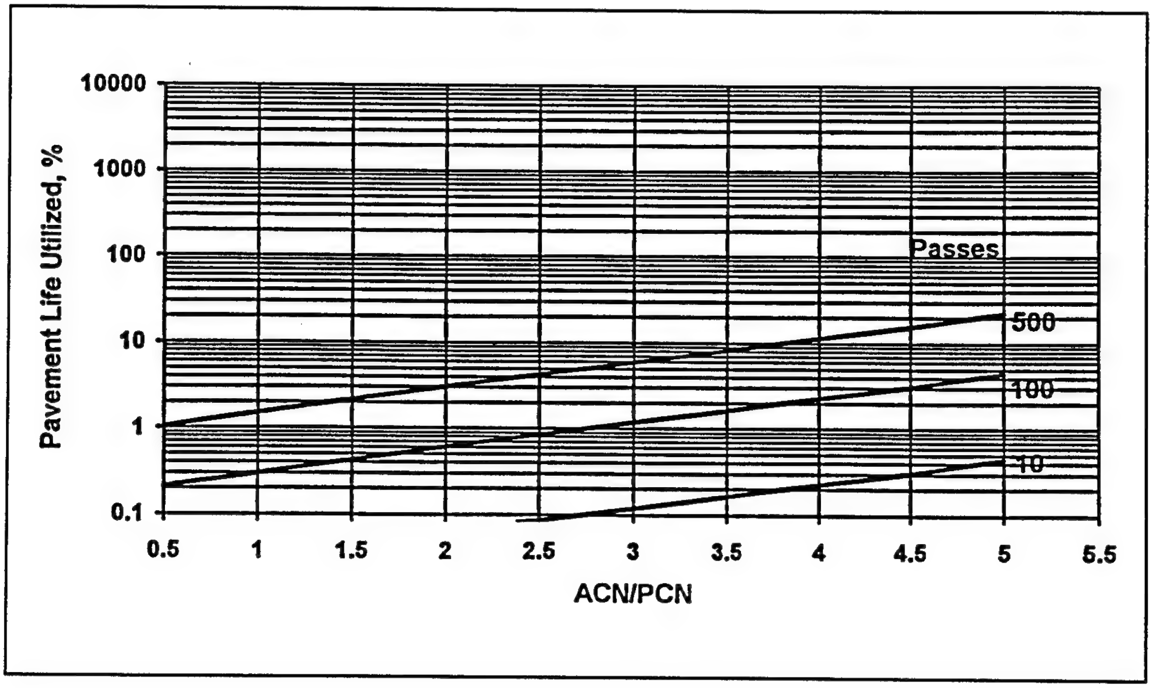


Figure D10. Pavement life utilized CH-47, rigid pavement (nonfrost)

Table D1
Determination of Critical Aircraft and Design Traffic

Fixed-Wing Aircraft	Gross Weight kg (lb)	20-year Projected Aircraft Passes	20-year Equivalent C-130 Passes
PCC Pavements			
C-130	61,236 (135,000)	12,000	12,000
20-year total equivalent C-130 passes @ 61,236 (135,000 lb) = 12,000			
AC Pavements			
C-130	61,236 (135,000)	12,000	12,000
20-year total equivalent C-130 passes @ 61,236 (135,000 lb) = 12,000			
Rotary-Wing Aircraft	**Gross Weight kg (lb)**	**20-year Projected Aircraft Passes**	**20-year Equivalent CH-47 Passes**
PCC Pavements			
CH-47	22,680 (50,000)	50,000	50,000
20-year total equivalent CH-47 passes @ 22,680 (50,000 lb) = 50,000			
AC Pavements			
CH-47	22,680 (50,000)	50,000	50,000
20-year total equivalent CH-47 passes @ 22,680 (50,000 lb) = 50,000			

Table D2
Determination of ACN Values for Critical Aircraft

PCC Pavements			
Design Aircraft	**Weight kg (lb)**	**Subgrade Category[1]**	**ACN or Required PCN**
C-130	61,236 (135,000)	A B C D	23 25 28 29
CH-47	22,680 (50,000)	A B C D	9 10 10 11
AC Pavements			
Design Aircraft	**Weight kg (lb)**	**Subgrade Category[1]**	**ACN or Required PCN**
C-130	61,236 (135,000)	A B C D	21 24 26 30
CH-47	22,680 (50,000)	A B C D	7 9 10 12

[1] See Table D-5 for subgrade category.

Table D3
Allowable Gross Aircraft Loads, PCNs and Overlay Requirements for the Projected Day-To-Day Traffic[1] Nonfrost Period

Pavement Facility	Feature	Type Traffic Area	Test Number or Station	Subgrade CBR/k percent[2]	Operational ACN[3]	Allowable Gross Aircraft Load[3] Mg(kips)	PCN	Theoretical Overlay Requirement, mm (in.)		
								AC	PCC	PCC with Bond Breaker
Runway 13-31	R1A	A	0+00-5+00	6	26/F/C/W/T	19 (43)[4]	7/F/C/W/T	203 (8.0)	–	–
Runway 13-31	R2A	A	5+00-10+00	7	26/F/C/W/T	117 (260)[6]	52/F/C/W/T	0.0	–	–
Runway 13-31	R3A	A	10+00-15+00	6	26/F/C/W/T	91 (201)[6]	40/F/C/W/T	0.0	–	–
Runway 13-31	R4A	A	15+00-40+00	7	26/F/C/W/T	99 (219)[6]	44/F/C/W/T	0.0	–	–
Runway 13-31	R5A	A	40+00-45+00	9	24/F/B/W/T	111 (246)[6]	45/F/B/W/T	0.0	–	–
Runway 13-31	R6A	A	45+00-50+00	10	24/F/B/W/T	121 (268)[6]	49/F/B/W/T	0.0	–	–
Alpha Lane	T5A-1	A	0+00-2+00	6	10/F/C/W/T	11 (24)	4/F/C/W/T	76 (3.0)	–	–
Alpha Lane	T5A-2	A	2+00-25+00	6	10/F/C/W/T	26 (57)[6]	12/F/C/W/T	0.0	–	–
Alpha Lane	T5A-3	A	25+00-27+00	6	10/F/C/W/T	11 (24)	4/F/C/W/T	76 (3.0)	–	–
Connecting Taxiway	T1A	A	0+00-10+50	6	10/F/C/W/T	13 (28)	5/F/C/W/T	64 (2.5)	–	–
North Taxiway	T2A	A	0+00-7+37	7	26/F/C/W/T	57 (127)	24/F/C/W/T	25 (1.0)	–	–
Midfield Taxiway	T3A	A	0+00-6+27	37 (140)	28/R/C/W/T	60 (132)	26/R/C/W/T	5 (0.2)	38 (1.5)	76 (3.0)
Compass Swing Base Taxiway	T4B	B	0+00-2+10	8	10/F/C/W/T	25 (55)[6]	11/F/C/W/T	0.0	–	–
North Warm-up Apron	A1B	B	0-2	6	26/F/C/W/T	31 (68)[4]	11/F/C/W/T	191 (7.5)	–	–

[1] The day-to-day traffic is equivalent to 12,000 passes of a 61,236 kg (135,000 lb) C-130 or 50,000 passes of a 22,680 kg (50,000) CH-47 (Features: T1A, T4B, T5A, A12B, and A13B).
[2] Values of CBR and k were calculated using the backcalculated subgrade modulus. Values of k are in KPa/mm (PSI/in.) units.
[3] Determined for the critical aircraft.
[4] The allowable load is less than the minimum load of the critical aircraft.
[5] Construction is recommended due to the ISM less than the lower limit of LOW.
[6] The allowable load is greater than the maximum load of the critical aircraft.

(Continued)

Table D3
(Concluded)

Pavement Facility	Feature	Type Traffic Area	Test Number or Station	Subgrade CBR/k percent[2]	Operational ACN[3]	Allowable Gross Load[3] Mg (kips)	PCN	Theoretical Overlay Requirement, mm (in.) AC	PCC	PCC with Bond Breaker
South Warm-up Apron	A2B	B	0-5	6	26/F/C/W/T	36 (80)	15/F/C/W/T	89 (3.5)	–	–
Hover Lane	A3B	B	0-16	8	26/F/C/W/T	31 (68)[4]	12/F/C/W/T	165 (6.5)	–	–
Parking Apron	A4B	B	1-6	28 (108)	28/R/C/W/T	43 (96)	18/R/C/W/T	76 (3.0)	117 (4.6)	168 (6.6)
Parking Apron	A5B	B	0-13	30 (114)	28/R/C/W/T	44 (98)	19/R/C/W/T	51 (2.0)	114 (4.5)	163 (6.4)
Parking Apron	A6B	B	1-17	30 (113)	28/R/C/W/T	43 (97)	19/R/C/W/T	64 (2.5)	114 (4.5)	163 (6.4)
Parking Apron	A7B	B	1-12	28 (105)	28/R/C/W/T	43 (95)	18/R/C/W/T	76 (3.0)	119 (4.7)	170 (6.7)
Parking Apron	A8B	B	1-12	28 (102)	28/R/C/W/T	42 (94)	18/R/C/W/T	76 (3.0)	121 (4.8)	170 (6.7)
Parking Apron	A9B	B	1-30	39 (150)	28/R/C/W/T	65 (145)[6]	29/R/C/W/T	0.0	0.0	0.0
East Rotary Wing Apron	A10B	B	1-5	24 (93)	11/R/D/W/T	41 (91)	11/R/D/W/T	102 (4.0)	130 (5.1)	180 (7.1)
West Rotary Wing Apron	A11B	B	1-5	24 (90)	11/R/D/W/T	41 (90)	11/R/D/W/T	114 (4.5)	135 (5.3)	185 (7.3)
Compass Swing Base	A12B	B	1-2	27 (102)	10/R/C/W/T	23 (51)[5]	10/R/C/W/T	5 (0.2)	10 (0.4)	30 (1.2)
Avum Hangar Apron	A13B	B	0-12	40 (154)	10/R/C/W/T	26 (57)[6]	12/R/C/W/T	0.0	0.0	0.0

[1] The day-to-day traffic is equivalent to 12,000 passes of a 61,236 kg (135,000 lb) C-130 or 50,000 passes of a 22,680 kg (50,000 lb) CH-47 (Features: T1A, T4B, T5A, A12B, and A13B).
[2] Values of CBR and k were calculated using the backcalculated subgrade modulus. Values of k are in KPa/mm (PSI/in.) units.
[3] Determined for the critical aircraft.
[4] The allowable load is less than the minimum load of the critical aircraft.
[5] Construction is recommended due to the ISM less than the lower limit of LOW.
[6] The allowable load is greater than the maximum load of the critical aircraft.

Table D4
Summary of Pavement Classification Numbers

Pavement Facility	Controlling Feature	PCN[1] Normal Non-Frost	PCN[1] Thaw-Weakening
Runway 13-31[2]	R3A	40/F/C/W/T	22/F/C/W/T
Alpha Lane Taxiway[3]	T5A, Sec 1 T5A, Sec 2 T5A, Sec 3	4/F/C/W/T 12/F/C/W/T 4/F/C/W/T	2/F/D/W/T 3/F/D/W/T 2/F/D/W/T
Connecting Taxiway	T1A	5/F/C/W/T	2/F/D/W/T
North Taxiway	T2A	24/F/C/W/T	6/F/D/W/T
Midfield Taxiway	T3A	26/R/C/W/T	18/R/D/W/T
Compass Swing Base Taxiway	T4B	11/F/C/W/T	3/F/D/W/T
North Warm-up Apron	A1B	11/F/C/W/T	4/F/D/W/T
South Warm-up Apron	A2B	15/F/C/W/T	6/F/D/W/T
Hover Lane	A3B	12/F/C/W/T	3/F/D/W/T
Parking Apron	A4B	18/R/C/W/T	12/R/D/W/T
Parking Apron	A5B	19/R/C/W/T	12/R/D/W/T
Parking Apron	A6B	19/R/C/W/T	12/R/D/W/T
Parking Apron	A7B	18/R/C/W/T	12/R/D/W/T
Parking Apron	A8B	18/R/C/W/T	11/R/D/W/T
Parking Apron	A9B	29/R/C/W/T	19/R/D/W/T
East Rotary Wing Apron	A10B	11/R/D/W/T	8/R/D/W/T
West Rotary Wing Apron	A11B	11/R/D/W/T	8/R/D/W/T
Compass Swing Base	A12B	10/R/C/W/T	7/R/D/W/T
Avum Hangar Apron	A13B	12/R/C/W/T	7/R/D/W/T

[1] Table D-5 describes the components of the PCN code.
[2] Feature R1A is overrun pavement.
[3] Features T5A, Sec 1 and T5A, Sec 3 are overrun pavements of an old runway.

Table D5
PCN Five-Part Code

PCN	Pavement Type	Subgrade Strength[1]	Tire Pressure[2]	Method of PCN Determination
Numerical value	R - rigid F - flexible	A B C D	W X Y Z	T - technical evaluation U - using aircraft

[1]Code	Category	Flexible Pavement CBR, %	Rigid Pavement k MN/m^3(psi/in.)
A	High	Over 13	Over 108(400)
B	Medium	8 - 13	54-108 (201-400)
C	Low	4 - 8	27-54 (100-200)
D	Ultralow	< 4	<27 (100)

[2]Code	Category	Tire Pressure, MPa (psi)
W	High	No limit
X	Medium	1.0-1.5 (146-217)
Y	Low	0.5- 1.0 (74-145)
Z	Ultralow	0-0.5 (0-73)

Appendix E
Micro PAVER Output Summary

INSPECTION REPORT

Network ID	- BUTTS			
Branch Name	- RUNWAY 13-31 OVERRUN		Section Length	- 500.00 LF
Branch Number	- R1A		Section Width	- 75.00 LF
Section Number	- 1	Family - DEFAULT	Section Area	- 37500.00 SF

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 3 RATING = FAIL

TOTAL NUMBER OF SAMPLE UNITS = 5
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 5
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMEND EVERY SAMPLE UNIT BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 1.7%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
43 BLOCK CR	HIGH	37500.00 (SF)	100.00	78.4
52 WEATH/RAVEL	HIGH	37500.00 (SF)	100.00	69.9
53 RUTTING	LOW	540.00 (SF)	1.44	16.9
53 RUTTING	HIGH	180.00 (SF)	.48	28.4

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD RELATED DISTRESSES = 23.41 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY RELATED DISTRESSES = 76.59 PERCENT DEDUCT VALUES.
OTHER RELATED DISTRESSES = .00 PERCENT DEDUCT VALUES.

INSPECTION REPORT

Network ID	- BUTTS		
Branch Name	- RUNWAY 13-31	Section Length	- 500.00 LF
Branch Number	- R2A	Section Width	- 75.00 LF
Section Number	- 1 Family - DEFAULT	Section Area	- 37500.00 SF

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 58 RATING = GOOD

TOTAL NUMBER OF SAMPLE UNITS = 5
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 5
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMEND EVERY SAMPLE UNIT BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 10.5%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
41 ALLIGATOR CR	LOW	300.00 (SF)	.80	18.5
48 L & T CR	LOW	1452.00 (LF)	3.87	12.2
48 L & T CR	MEDIUM	1560.00 (LF)	4.16	23.3
52 WEATH/RAVEL	LOW	37500.00 (SF)	100.00	26.4

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD	RELATED DISTRESSES =	22.98 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY	RELATED DISTRESSES =	77.02 PERCENT DEDUCT VALUES.
OTHER	RELATED DISTRESSES =	.00 PERCENT DEDUCT VALUES.

INSPECTION REPORT

Network ID	- BUTTS		
Branch Name	- RUNWAY 13-31	Section Length -	500.00 LF
Branch Number	- R3A	Section Width -	75.00 LF
Section Number	- 1 Family - DEFAULT	Section Area -	37500.00 SF

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 59 RATING = GOOD

TOTAL NUMBER OF SAMPLE UNITS = 5
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 5
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMEND EVERY SAMPLE UNIT BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 9.8%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
41 ALLIGATOR CR	LOW	600.00 (SF)	1.60	24.9
48 L & T CR	LOW	1341.00 (LF)	3.58	11.5
48 L & T CR	MEDIUM	1089.00 (LF)	2.90	19.1
52 WEATH/RAVEL	LOW	37500.00 (SF)	100.00	26.4

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD	RELATED DISTRESSES =	30.43	PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY	RELATED DISTRESSES =	69.57	PERCENT DEDUCT VALUES.
OTHER	RELATED DISTRESSES =	.00	PERCENT DEDUCT VALUES.

INSPECTION REPORT

Network ID	- BUTTS		
Branch Name	- RUNWAY 13-31	Section Length	- 2560.00 LF
Branch Number	- R4A	Section Width	- 75.00 LF
Section Number	- 1 Family - DEFAULT	Section Area	- 192000.00 SF

Inspection Date: DEC/08/1995

Riding Quality : Safety: Drainage Cond.:

Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 55 RATING = FAIR

TOTAL NUMBER OF SAMPLE UNITS = 25

NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 10

NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:

RECOMMENDED MINIMUM OF 11 RANDOM SAMPLE UNITS TO BE SURVEYED.

STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 9.6%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
41 ALLIGATOR CR	LOW	230.40 (SF)	.12	7.1
48 L & T CR	LOW	6869.76 (LF)	3.58	11.5
48 L & T CR	MEDIUM	5664.00 (LF)	2.95	19.3
52 WEATH/RAVEL	LOW	192000.00 (SF)	100.00	26.4
53 RUTTING	LOW	3406.08 (SF)	1.77	17.9
53 RUTTING	MEDIUM	2876.16 (SF)	1.50	27.0

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD RELATED DISTRESSES = 47.67 PERCENT DEDUCT VALUES.

CLIMATE/DURABILITY RELATED DISTRESSES = 52.33 PERCENT DEDUCT VALUES.

OTHER RELATED DISTRESSES = .00 PERCENT DEDUCT VALUES.

INSPECTION REPORT

Network ID - BUTTS
Branch Name - RUNWAY 13-31
Branch Number - R5A
Section Number - 1 Family - DEFAULT

Section Length - 500.00 LF
Section Width - 75.00 LF
Section Area - 37500.00 SF

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 55 RATING = FAIR

TOTAL NUMBER OF SAMPLE UNITS = 5
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 5
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMEND EVERY SAMPLE UNIT BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 6.2%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
48 L & T CR	LOW	1584.00 (LF)	4.22	13.0
48 L & T CR	MEDIUM	1092.00 (LF)	2.91	19.2
52 WEATH/RAVEL	LOW	37500.00 (SF)	100.00	26.4
53 RUTTING	LOW	2196.00 (SF)	5.86	24.6

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD	RELATED DISTRESSES =	29.60	PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY	RELATED DISTRESSES =	70.40	PERCENT DEDUCT VALUES.
OTHER	RELATED DISTRESSES =	.00	PERCENT DEDUCT VALUES.

INSPECTION REPORT

```
=============================================================================
Network ID       - BUTTS
Branch Name      - RUNWAY 13-31                    Section Length  -    500.00 LF
Branch Number    - R6A                             Section Width   -     75.00 LF
Section Number   - 1        Family - DEFAULT       Section Area    -  37500.00 SF
=============================================================================
  Inspection Date: DEC/08/1995
  Riding Quality :            Safety:       Drainage Cond.:
  Shoulder Cond. :      Overall Cond.:              F.O.D.:
  -----------------------------------------------------------------------
  ------------------------------------------------------------------------
  PCI OF SECTION =  59                          RATING = GOOD

  TOTAL NUMBER OF SAMPLE UNITS =      5
  NUMBER OF RANDOM SAMPLE UNITS SURVEYED      =      5
  NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED =      0

  FOR PROJECT LEVEL ANALYSIS:
  RECOMMEND EVERY SAMPLE UNIT BE SURVEYED.
  STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED =   6.3%

       *** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

  DISTRESS-TYPE     SEVERITY        QUANTITY        DENSITY %     DEDUCT VALUE
  41 ALLIGATOR CR    LOW             90.00 (SF)          .24              9.5
  48 L & T CR        LOW           1914.00 (LF)         5.10             15.0
  48 L & T CR        MEDIUM         979.50 (LF)         2.61             18.1
  52 WEATH/RAVEL     LOW          37500.00 (SF)       100.00             26.4
  53 RUTTING         LOW            105.00 (SF)          .28             10.8

     *** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

  LOAD                RELATED DISTRESSES =  25.44 PERCENT DEDUCT VALUES.
  CLIMATE/DURABILITY RELATED DISTRESSES =  74.56 PERCENT DEDUCT VALUES.
  OTHER               RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
```

INSPECTION REPORT

```
==============================================================================
Network ID      - BUTTS
Branch Name     - CONNECTING TAXIWAY                Section Length  -   1050.00 LF
Branch Number   - T1A                               Section Width   -     50.00 LF
Section Number  - 1        Family - DEFAULT         Section Area    -  52500.00 SF
==============================================================================
  Inspection Date: DEC/08/1995
  Riding Quality :             Safety:        Drainage Cond.:
  Shoulder Cond. :       Overall Cond.:                F.O.D.:
  ----------------------------------------------------------------------
  ----------------------------------------------------------------------
  PCI OF SECTION =    3                         RATING = FAIL

  TOTAL NUMBER OF SAMPLE UNITS =    10
  NUMBER OF RANDOM SAMPLE UNITS SURVEYED      =     7
  NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED =     0

  FOR PROJECT LEVEL ANALYSIS:
  RECOMMENDED MINIMUM OF     5 RANDOM SAMPLE UNITS TO BE SURVEYED.
  STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED =   1.4%

        *** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

  DISTRESS-TYPE     SEVERITY      QUANTITY        DENSITY %     DEDUCT VALUE
  43 BLOCK CR        HIGH       52500.00 (SF)      100.00              78.4
  52 WEATH/RAVEL     HIGH       52500.00 (SF)      100.00              69.9
  53 RUTTING         LOW          675.00 (SF)        1.29              16.4
  53 RUTTING         MEDIUM       315.00 (SF)         .60              21.2

     *** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

  LOAD               RELATED DISTRESSES =  20.23 PERCENT DEDUCT VALUES.
  CLIMATE/DURABILITY RELATED DISTRESSES =  79.77 PERCENT DEDUCT VALUES.
  OTHER              RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
```

INSPECTION REPORT

Network ID	- BUTTS		
Branch Name	- NORTH TAXIWAY		
Branch Number	- T2A	Section Length	- 737.00 LF
Section Number	- 1 Family - DEFAULT	Section Width	- 40.00 LF
		Section Area	- 29480.00 SF

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 3 RATING = FAIL

TOTAL NUMBER OF SAMPLE UNITS = 7
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 5
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF 5 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 1.7%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
43 BLOCK CR	HIGH	29480.00 (SF)	100.00	78.4
52 WEATH/RAVEL	HIGH	29480.00 (SF)	100.00	69.9
53 RUTTING	LOW	1407.67 (SF)	4.78	23.3
53 RUTTING	HIGH	589.60 (SF)	2.00	40.4

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD	RELATED DISTRESSES =	30.07	PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY	RELATED DISTRESSES =	69.93	PERCENT DEDUCT VALUES.
OTHER	RELATED DISTRESSES =	.00	PERCENT DEDUCT VALUES.

INSPECTION REPORT

Network ID	- BUTTS		
Branch Name	- MIDFIELD TAXIWAY	Slab Length -	20.00 LF
Branch Number	- T3A	Slab Width -	20.00 LF
Section Number	- 1 Family - DEFAULT	Number of Slabs -	62

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 49 RATING = FAIR

TOTAL NUMBER OF SAMPLE UNITS = 3
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 3
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMEND EVERY SAMPLE UNIT BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 2.6%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
62 CORNER BREAK	MEDIUM	1 (SLABS)	1.67	2.3
64 DURABIL. CR	LOW	2 (SLABS)	3.33	1.4
65 JT SEAL DMG	HIGH	62 (SLABS)	100.00	12.0
70 SCALING	LOW	5 (SLABS)	8.33	3.4
71 FAULTING	LOW	2 (SLABS)	3.33	3.3
74 JOINT SPALL	LOW	19 (SLABS)	31.67	8.3
74 JOINT SPALL	MEDIUM	10 (SLABS)	16.67	11.9
74 JOINT SPALL	HIGH	7 (SLABS)	11.67	22.5
75 CORNER SPALL	LOW	14 (SLABS)	23.33	8.0
75 CORNER SPALL	MEDIUM	2 (SLABS)	3.33	2.3

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD	RELATED DISTRESSES =	3.11 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY	RELATED DISTRESSES =	17.71 PERCENT DEDUCT VALUES.
OTHER	RELATED DISTRESSES =	79.18 PERCENT DEDUCT VALUES.

INSPECTION REPORT

Network ID	- BUTTS		
Branch Name	- COMPASS SWING BASE TW	Section Length	- 210.00 LF
Branch Number	- T4B	Section Width	- 40.00 LF
Section Number	- 1 Family - DEFAULT	Section Area	- 8400.00 SF

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 22 RATING = V. POOR

TOTAL NUMBER OF SAMPLE UNITS = 2
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 2
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMEND EVERY SAMPLE UNIT BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 2.8%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
48 L & T CR	LOW	68.25 (LF)	.81	4.6
48 L & T CR	MEDIUM	225.75 (LF)	2.69	18.4
48 L & T CR	HIGH	703.50 (LF)	8.38	50.6
52 WEATH/RAVEL	MEDIUM	8400.00 (SF)	100.00	56.8

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD	RELATED DISTRESSES =	.00	PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY	RELATED DISTRESSES =	100.00	PERCENT DEDUCT VALUES.
OTHER	RELATED DISTRESSES =	.00	PERCENT DEDUCT VALUES.

INSPECTION REPORT

Network ID	- BUTTS		
Branch Name	- RUNWAY 4-22 - HOVER LANE	Section Length	- 2700.00 LF
Branch Number	- T5A	Section Width	- 75.00 LF
Section Number	- 1 Family - DEFAULT	Section Area	- 202500.00 SF

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 5 RATING = FAIL

TOTAL NUMBER OF SAMPLE UNITS = 27
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 12
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF 5 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = .0%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
43 BLOCK CR	HIGH	202500.00 (SF)	100.00	78.4
52 WEATH/RAVEL	HIGH	202500.00 (SF)	100.00	69.9

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD RELATED DISTRESSES = .00 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY RELATED DISTRESSES = 100.00 PERCENT DEDUCT VALUES.
OTHER RELATED DISTRESSES = .00 PERCENT DEDUCT VALUES.

INSPECTION REPORT

```
Network ID      - BUTTS
Branch Name     - NORTH WARM-UP APRON          Section Length -       .00 LF
Branch Number   - A1B                          Section Width  -       .00 LF
Section Number  - 1      Family - DEFAULT      Section Area   -  33750.00 SF

  Inspection Date: DEC/08/1995
  Riding Quality :            Safety:        Drainage Cond.:
  Shoulder Cond. :      Overall Cond.:              F.O.D.:

  PCI OF SECTION =   5                            RATING = FAIL

  TOTAL NUMBER OF SAMPLE UNITS =       7
  NUMBER OF RANDOM SAMPLE UNITS SURVEYED      =     5
  NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED  =     0

  FOR PROJECT LEVEL ANALYSIS:
  RECOMMENDED MINIMUM OF      5 RANDOM SAMPLE UNITS TO BE SURVEYED.
  STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED =    .0%
```

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
43 BLOCK CR	HIGH	33750.00 (SF)	100.00	78.4
52 WEATH/RAVEL	HIGH	33750.00 (SF)	100.00	69.9

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

```
LOAD               RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY RELATED DISTRESSES = 100.00 PERCENT DEDUCT VALUES.
OTHER              RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
```

INSPECTION REPORT

```
Network ID       - BUTTS
Branch Name      - SOUTH WARM-UP APRON            Section Length  -       .00 LF
Branch Number    - A2B                            Section Width   -       .00 LF
Section Number   - 1        Family - DEFAULT      Section Area    -  53748.00 SF
```

Inspection Date: DEC/08/1995
Riding Quality :   Safety: Drainage Cond.:
Shoulder Cond. :   Overall Cond.:   F.O.D.:

PCI OF SECTION = 3   RATING = FAIL

TOTAL NUMBER OF SAMPLE UNITS = 11
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 7
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF 5 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 1.7%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
43 BLOCK CR	HIGH	53748.00 (SF)	100.00	78.4
50 PATCHING	HIGH	71.66 (SF)	.13	15.7
52 WEATH/RAVEL	HIGH	53748.00 (SF)	100.00	69.9
53 RUTTING	LOW	601.98 (SF)	1.12	15.8
53 RUTTING	MEDIUM	895.80 (SF)	1.67	27.8
53 RUTTING	HIGH	1297.12 (SF)	2.41	42.4

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

```
LOAD                RELATED DISTRESSES =  34.40 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY  RELATED DISTRESSES =  65.60 PERCENT DEDUCT VALUES.
OTHER               RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
```

INSPECTION REPORT

```
Network ID       - BUTTS
Branch Name      - HOVER LANE                       Section Length  -        .00 LF
Branch Number    - A3B                              Section Width   -        .00 LF
Section Number   - 1        Family - DEFAULT        Section Area    - 257949.00 SF
```

```
Inspection Date: DEC/08/1995
Riding Quality :              Safety:          Drainage Cond.:
Shoulder Cond. :        Overall Cond.:                 F.O.D.:
```

PCI OF SECTION = 4 RATING = FAIL

TOTAL NUMBER OF SAMPLE UNITS = 16
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 8
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF 5 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = .0%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
43 BLOCK CR	HIGH	257949.00 (SF)	100.00	78.4
50 PATCHING	LOW	735.15 (SF)	.29	2.1
52 WEATH/RAVEL	HIGH	257949.00 (SF)	100.00	69.9

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

```
LOAD               RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY RELATED DISTRESSES = 100.00 PERCENT DEDUCT VALUES.
OTHER              RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
```

INSPECTION REPORT

Network ID	- BUTTS		
Branch Name	- PARKING APRON	Slab Length -	12.50 LF
Branch Number	- A4B	Slab Width -	11.00 LF
Section Number	- 1 Family - DEFAULT	Number of Slabs -	315

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 82 RATING = V. GOOD

TOTAL NUMBER OF SAMPLE UNITS = 9
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 9
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF 5 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 5.3%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
63 LINEAR CR	LOW	5 (SLABS)	1.67	1.8
65 JT SEAL DMG	HIGH	315 (SLABS)	100.00	12.0
66 SMALL PATCH	LOW	5 (SLABS)	1.67	.4
67 LARGE PATCH	LOW	3 (SLABS)	1.11	1.0
67 LARGE PATCH	MEDIUM	1 (SLABS)	.56	2.5
69 PUMPING	N/A	7 (SLABS)	2.22	2.3
71 FAULTING	LOW	1 (SLABS)	.56	1.0
74 JOINT SPALL	LOW	1 (SLABS)	.56	.6
75 CORNER SPALL	LOW	3 (SLABS)	1.11	.4

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD RELATED DISTRESSES = 8.28 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY RELATED DISTRESSES = 54.60 PERCENT DEDUCT VALUES.
OTHER RELATED DISTRESSES = 37.11 PERCENT DEDUCT VALUES.

INSPECTION REPORT

Network ID	- BUTTS		
Branch Name	- PARKING APRON	Slab Length -	12.50 LF
Branch Number	- A5B	Slab Width -	11.00 LF
Section Number	- 1 Family - DEFAULT	Number of Slabs -	988

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 83 RATING = V. GOOD

TOTAL NUMBER OF SAMPLE UNITS = 20
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 13
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF 6 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 6.0%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
62 CORNER BREAK	LOW	7 (SLABS)	.77	.7
63 LINEAR CR	LOW	7 (SLABS)	.77	1.0
63 LINEAR CR	MEDIUM	11 (SLABS)	1.15	2.0
64 DURABIL. CR	LOW	7 (SLABS)	.77	.5
65 JT SEAL DMG	HIGH	988 (SLABS)	100.00	12.0
66 SMALL PATCH	LOW	3 (SLABS)	.38	.2
73 SHRINKAGE CR	N/A	3 (SLABS)	.38	.6
74 JOINT SPALL	LOW	7 (SLABS)	.77	.6
74 JOINT SPALL	MEDIUM	3 (SLABS)	.38	1.0
75 CORNER SPALL	LOW	15 (SLABS)	1.54	.7

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD	RELATED DISTRESSES =	19.35 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY	RELATED DISTRESSES =	64.91 PERCENT DEDUCT VALUES.
OTHER	RELATED DISTRESSES =	15.74 PERCENT DEDUCT VALUES.

INSPECTION REPORT

```
Network ID       - BUTTS
Branch Name      - PARKING APRON                    Slab Length     -    12.50 LF
Branch Number    - A6B                              Slab Width      -    11.00 LF
Section Number   - 1        Family - DEFAULT        Number of Slabs -     1500
```

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 76 RATING = V. GOOD

TOTAL NUMBER OF SAMPLE UNITS = 22
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 12
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF 8 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 7.7%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
63 LINEAR CR	LOW	18 (SLABS)	1.24	1.4
64 DURABIL. CR	LOW	62 (SLABS)	4.15	1.5
65 JT SEAL DMG	HIGH	1500 (SLABS)	100.00	12.0
67 LARGE PATCH	LOW	37 (SLABS)	2.49	1.9
67 LARGE PATCH	HIGH	31 (SLABS)	2.07	8.0
70 SCALING	LOW	37 (SLABS)	2.49	1.1
71 FAULTING	LOW	6 (SLABS)	.41	1.0
74 JOINT SPALL	LOW	24 (SLABS)	1.66	1.4
74 JOINT SPALL	MEDIUM	18 (SLABS)	1.24	1.7
75 CORNER SPALL	LOW	6 (SLABS)	.41	.3
75 CORNER SPALL	MEDIUM	6 (SLABS)	.41	.8
75 CORNER SPALL	HIGH	6 (SLABS)	.41	1.2

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

```
LOAD                RELATED DISTRESSES =  4.26 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY  RELATED DISTRESSES = 41.77 PERCENT DEDUCT VALUES.
OTHER               RELATED DISTRESSES = 53.98 PERCENT DEDUCT VALUES.
```

INSPECTION REPORT

```
Network ID      - BUTTS
Branch Name     - PARKING APRON                       Slab Length      -    12.50 LF
Branch Number   - A7B                                 Slab Width       -    12.50 LF
Section Number  - 1        Family - DEFAULT           Number of Slabs  -     300

Inspection Date: DEC/08/1995
Riding Quality :              Safety:          Drainage Cond.:
Shoulder Cond. :       Overall Cond.:                 F.O.D.:

PCI OF SECTION =  80                                  RATING = V. GOOD

TOTAL NUMBER OF SAMPLE UNITS =     15
NUMBER OF RANDOM SAMPLE UNITS SURVEYED       =     9
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED =       0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF     5 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED =    5.4%
```

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
65 JT SEAL DMG	LOW	28 (SLABS)	9.60	2.0
65 JT SEAL DMG	HIGH	271 (SLABS)	90.40	12.0
70 SCALING	LOW	3 (SLABS)	1.13	.6
70 SCALING	HIGH	1 (SLABS)	.56	2.0
73 SHRINKAGE CR	N/A	3 (SLABS)	1.13	.7
74 JOINT SPALL	LOW	25 (SLABS)	8.47	3.0
74 JOINT SPALL	MEDIUM	8 (SLABS)	2.82	3.1
74 JOINT SPALL	HIGH	1 (SLABS)	.56	3.0
75 CORNER SPALL	LOW	6 (SLABS)	2.26	.9
75 CORNER SPALL	MEDIUM	3 (SLABS)	1.13	.8

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

```
LOAD               RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY RELATED DISTRESSES =  49.59 PERCENT DEDUCT VALUES.
OTHER              RELATED DISTRESSES =  50.41 PERCENT DEDUCT VALUES.
```

INSPECTION REPORT

Network ID	- BUTTS		
Branch Name	- PARKING APRON	Slab Length -	12.50 LF
Branch Number	- A8B	Slab Width -	12.50 LF
Section Number	- 1 Family - DEFAULT	Number of Slabs -	342

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 86 RATING = EXCELLENT

TOTAL NUMBER OF SAMPLE UNITS = 19
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 11
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF 5 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 5.2%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
62 CORNER BREAK	LOW	1 (SLABS)	.45	.7
63 LINEAR CR	LOW	1 (SLABS)	.45	1.0
65 JT SEAL DMG	MEDIUM	93 (SLABS)	27.27	7.0
65 JT SEAL DMG	HIGH	248 (SLABS)	72.73	12.0
70 SCALING	LOW	6 (SLABS)	1.82	.9
74 JOINT SPALL	MEDIUM	3 (SLABS)	.91	1.0
75 CORNER SPALL	LOW	1 (SLABS)	.45	.3
75 CORNER SPALL	MEDIUM	1 (SLABS)	.45	.8

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD	RELATED DISTRESSES =	7.17 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY	RELATED DISTRESSES =	80.14 PERCENT DEDUCT VALUES.
OTHER	RELATED DISTRESSES =	12.69 PERCENT DEDUCT VALUES.

INSPECTION REPORT

```
Network ID       - BUTTS
Branch Name      - PARKING APRON                Slab Length      -   18.00 LF
Branch Number    - A9B                          Slab Width       -   18.00 LF
Section Number   - 1        Family - DEFAULT    Number of Slabs  -    680

  Inspection Date: DEC/08/1995
  Riding Quality :              Safety:         Drainage Cond.:
  Shoulder Cond. :         Overall Cond.:              F.O.D.:
```

PCI OF SECTION = 66 RATING = GOOD

TOTAL NUMBER OF SAMPLE UNITS = 34
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 21
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF 21 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 16.9%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
63 LINEAR CR	LOW	4 (SLABS)	.71	1.0
63 LINEAR CR	MEDIUM	6 (SLABS)	.95	1.0
65 JT SEAL DMG	LOW	32 (SLABS)	4.76	2.0
65 JT SEAL DMG	MEDIUM	647 (SLABS)	95.24	7.0
71 FAULTING	LOW	42 (SLABS)	6.19	5.5
71 FAULTING	MEDIUM	24 (SLABS)	3.57	6.8
71 FAULTING	HIGH	12 (SLABS)	1.90	6.6
74 JOINT SPALL	LOW	131 (SLABS)	19.29	5.8
74 JOINT SPALL	MEDIUM	22 (SLABS)	3.33	3.4
74 JOINT SPALL	HIGH	21 (SLABS)	3.10	9.5
75 CORNER SPALL	LOW	40 (SLABS)	5.95	2.2
75 CORNER SPALL	MEDIUM	19 (SLABS)	2.86	2.0

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

```
LOAD                RELATED DISTRESSES =   3.80 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY  RELATED DISTRESSES =  17.11 PERCENT DEDUCT VALUES.
OTHER               RELATED DISTRESSES =  79.09 PERCENT DEDUCT VALUES.
```

INSPECTION REPORT

Network ID	- BUTTS		
Branch Name	- EAST ROTARY WING PK APR	Slab Length	- 12.50 LF
Branch Number	- A10B	Slab Width	- 11.00 LF
Section Number	- 1 Family - DEFAULT	Number of Slabs	- 390

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 85 RATING = V. GOOD

TOTAL NUMBER OF SAMPLE UNITS = 19
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 12
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF 5 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 4.6%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
65 JT SEAL DMG	HIGH	390 (SLABS)	100.00	12.0
71 FAULTING	LOW	8 (SLABS)	2.08	2.4
71 FAULTING	MEDIUM	1 (SLABS)	.42	2.0
74 JOINT SPALL	LOW	9 (SLABS)	2.50	1.6
75 CORNER SPALL	LOW	1 (SLABS)	.42	.3

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD	RELATED DISTRESSES =	.00 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY	RELATED DISTRESSES =	65.45 PERCENT DEDUCT VALUES.
OTHER	RELATED DISTRESSES =	34.55 PERCENT DEDUCT VALUES.

INSPECTION REPORT

Network ID	- BUTTS		
Branch Name	- WEST ROTARY WING PK APR	Slab Length -	12.50 LF
Branch Number	- A11B	Slab Width -	11.00 LF
Section Number	- 1 Family - DEFAULT	Number of Slabs -	390

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 81 RATING = V. GOOD

TOTAL NUMBER OF SAMPLE UNITS = 19
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 12
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF 8 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 7.9%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
62 CORNER BREAK	MEDIUM	1 (SLABS)	.42	1.5
63 LINEAR CR	LOW	1 (SLABS)	.42	1.0
65 JT SEAL DMG	LOW	32 (SLABS)	8.33	2.0
65 JT SEAL DMG	HIGH	357 (SLABS)	91.67	12.0
69 PUMPING	N/A	6 (SLABS)	1.67	2.1
71 FAULTING	LOW	1 (SLABS)	.42	1.0
72 SHAT. SLAB	MEDIUM	1 (SLABS)	.42	5.0
74 JOINT SPALL	LOW	11 (SLABS)	2.92	1.7
74 JOINT SPALL	MEDIUM	4 (SLABS)	1.25	1.7
74 JOINT SPALL	HIGH	1 (SLABS)	.42	3.0
75 CORNER SPALL	LOW	8 (SLABS)	2.08	.9

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD RELATED DISTRESSES = 23.50 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY RELATED DISTRESSES = 43.86 PERCENT DEDUCT VALUES.
OTHER RELATED DISTRESSES = 32.64 PERCENT DEDUCT VALUES.

INSPECTION REPORT

```
==========================================================================
Network ID      - BUTTS
Branch Name     - COMPASS SWING BASE                  Slab Length      -    12.50 LF
Branch Number   - A12B                                Slab Width       -    12.50 LF
Section Number  - 1         Family - DEFAULT          Number of Slabs -       64
==========================================================================
  Inspection Date: DEC/08/1995
  Riding Quality :              Safety:          Drainage Cond.:
  Shoulder Cond. :       Overall Cond.:                 F.O.D.:
  -----------------------------------------------------------------
  -----------------------------------------------------------------
  PCI OF SECTION =  79                               RATING = V. GOOD

  TOTAL NUMBER OF SAMPLE UNITS =       4
  NUMBER OF RANDOM SAMPLE UNITS SURVEYED      =     4
  NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED =     0

  FOR PROJECT LEVEL ANALYSIS:
  RECOMMEND EVERY SAMPLE UNIT BE SURVEYED.
  STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED =   4.5%
```

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
65 JT SEAL DMG	HIGH	64 (SLABS)	100.00	12.0
74 JOINT SPALL	LOW	4 (SLABS)	6.25	2.5
74 JOINT SPALL	MEDIUM	2 (SLABS)	3.13	3.3
74 JOINT SPALL	HIGH	1 (SLABS)	1.56	5.1
75 CORNER SPALL	LOW	1 (SLABS)	1.56	.7
75 CORNER SPALL	MEDIUM	1 (SLABS)	1.56	1.1

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

```
LOAD               RELATED DISTRESSES =    .00 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY RELATED DISTRESSES =  48.84 PERCENT DEDUCT VALUES.
OTHER              RELATED DISTRESSES =  51.16 PERCENT DEDUCT VALUES.
```

INSPECTION REPORT

Network ID	- BUTTS			
Branch Name	- AVUM HANGAR APRON		Slab Length	- 15.00 LF
Branch Number	- A13B		Slab Width	- 15.00 LF
Section Number	- 1	Family - DEFAULT	Number of Slabs	- 2870

Inspection Date: DEC/08/1995
Riding Quality : Safety: Drainage Cond.:
Shoulder Cond. : Overall Cond.: F.O.D.:

PCI OF SECTION = 92 RATING = EXCELLENT

TOTAL NUMBER OF SAMPLE UNITS = 137
NUMBER OF RANDOM SAMPLE UNITS SURVEYED = 30
NUMBER OF ADDITIONAL SAMPLE UNITS SURVEYED = 0

FOR PROJECT LEVEL ANALYSIS:
RECOMMENDED MINIMUM OF 5 RANDOM SAMPLE UNITS TO BE SURVEYED.
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED = 4.2%

*** EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION ***

DISTRESS-TYPE	SEVERITY	QUANTITY	DENSITY %	DEDUCT VALUE
62 CORNER BREAK	LOW	9 (SLABS)	.33	.7
63 LINEAR CR	LOW	4 (SLABS)	.17	1.0
65 JT SEAL DMG	LOW	2870 (SLABS)	100.00	2.0
66 SMALL PATCH	LOW	9 (SLABS)	.33	.2
67 LARGE PATCH	LOW	9 (SLABS)	.33	.7
70 SCALING	LOW	4 (SLABS)	.17	.5
74 JOINT SPALL	LOW	166 (SLABS)	5.79	2.3
74 JOINT SPALL	MEDIUM	57 (SLABS)	1.99	2.6
75 CORNER SPALL	LOW	38 (SLABS)	1.32	.6
75 CORNER SPALL	MEDIUM	4 (SLABS)	.17	.8

*** PERCENT OF DEDUCT VALUES BASED ON DISTRESS MECHANISM ***

LOAD RELATED DISTRESSES = 14.88 PERCENT DEDUCT VALUES.
CLIMATE/DURABILITY RELATED DISTRESSES = 17.51 PERCENT DEDUCT VALUES.
OTHER RELATED DISTRESSES = 67.60 PERCENT DEDUCT VALUES.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1.AGENCY USE ONLY ***(Leave blank)***

2.REPORT DATE
August 1996

3.REPORT TYPE AND DATES COVERED
Final report

4.TITLE AND SUBTITLE
Airfield Pavement Evaluation, Butts Army Airfield, Fort Carson, Colorado

5.FUNDING NUMBERS

6.AUTHOR(S)
Jeb S. Tingle

7.PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

8.PERFORMING ORGANIZATION REPORT NUMBER
Miscellaneous Paper
GL-96-19

9.SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Program Manager: U.S. Army Center for Public Works (CECPW-ER)
7701 Telegraph Road
Alexandria, VA 22310-3862

10.SPONSORING/MONITORING AGENCY REPORT NUMBER

11.SUPPLEMENTARY NOTES

12a.DISTRIBUTION/AVAILABILITY STATEMENT
Distribution is authorized to U.S. Government agencies only; test and evaluation; August 1996. Other requests for this document shall be referred to Headquarters, U.S. Army Corps of Engineers (CEMP-ET), Washington, DC 20314-1000.

12b.DISTRIBUTION CODE

13.ABSTRACT ***(Maximum 200 words)***

An airfield pavement investigation was performed in December 1995 at Butts Army Airfield, Fort Carson, Colorado, to develop information pertaining to the structural adequacy of the airfield pavements for continued use under current mission and upgrading of the pavements for mission changes. The pavement surface condition was evaluated by use of the pavement condition index (PCI) condition survey procedure, and a nondestructive evaluation procedure was used to determine the load-carrying capability of the pavements and overlay requirements for continued use of the pavements under current missions. Results of the evaluation are presented including: (a) a tabulation of the existing pavement features, (b) the results of the nondestructive tests performed using a falling weight deflectometer, (c) the PCI and rating of the surface of each pavement feature, (d) a structural evaluation and overlay requirements for 12,000 passes of the 61,236-kg (135,000-lb) C-130 aircraft and 50,000 passes of a 22,680-kg (50,000-lb) CH-47 aircraft, (e) the pavement classification number for each pavement facility, and (f) maintenance and repair recommendations based on the structural evaluation and condition survey.

14.SUBJECT TERMS
See reverse.

15.NUMBER OF PAGES
152

16.PRICE CODE

17.SECURITY CLASSIFICATION OF REPORT	18.SECURITY CLASSIFICATION OF THIS PAGE	19.SECURITY CLASSIFICATION OF ABSTRACT	20.LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED		

14. (Concluded).

Aircraft classification number
Allowable gross aircraft load
Butts Army Airfield
Nondestructive testing
Overlay requirements
Pavement classification number
Pavement condition index